Repair Manual
for Diesel engines series
RY

cod. 00497R0990

RUGGERINI DIESEL

Ruggerini motori

FOREWORD

This instruction manual includes all the technical information needed to make any of the repairs required for the engines in question.
It is very important to strictly comply with all the instructions given to ensure that the repair work is carried out as quickly and safely as possible.

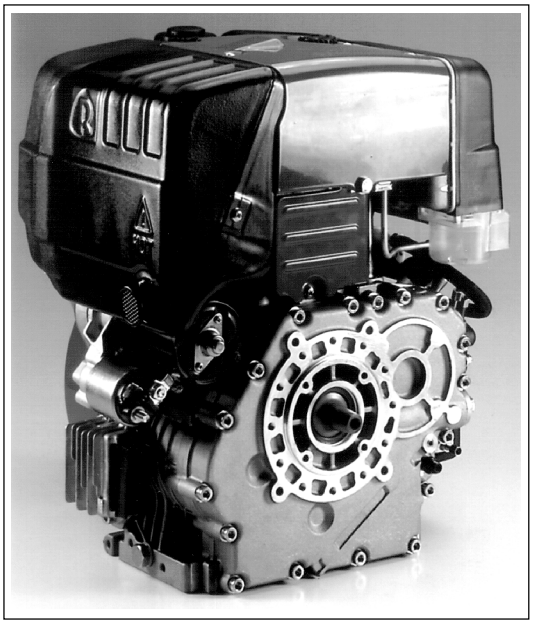
WORKSHOP REGULATIONS

- *Always use the right tools for the repairs. Use of makeshift equipment could damage the engine components*
- *Lightly tap solidly joined parts with a plastic or wooden mallet in order to split the assemblies*
- *To facilitate the re-assembly operations, mark any parts without reference points*
- *Separate the various components into distinct groups; retighten the nuts and bolts of each assembly*
- *Wash each component with Diesel fuel or petroleum before proceeding with the dimensional inspections*
- *During the assembly operations, thoroughly clean all parts, spread lubricating oil on the mobile engine components and replace pins, retention rings, seals, washers and self-locking nuts.*

WARNING

*Only use **GENUINE RUGGERINI SPARES** to ensure a good result.*

SERIES RY DIESEL ENGINES



1. TECHNICAL SPECIFICATIONS

MODEL		Ry85.0	Ry85.1	Ry100	Ry101	Ry120	Ry121
Cycle				4-stroke Diesel			
Injection				direct			
Cooling				forced air with fan flywheel			
Lubrication				forced with vane pump			
Governor				centrifugal with weights			
Number of cylinders				1			
Swept volume	*cc.*	382	382	431	431	505	505
Bore	*mm*	80	80	85	85	87	87
Stroke	*mm*	76	76	76	76	85	85
Rpm		3000	3600	3000	3600	3000	3600
Compression ratio		19.5:1	19.5:1	18.5:1	18.5:1	18.5:1	18.5:1
PTO spinning direction				anti-clockwise			
Maximum torque	*Nm(rpm)*	19(2200)	19(2200)	22(2200)	22(2200)	27(2200)	27(2200)
Governor rpm error margin		5%	5%	5%	5%	5%	5%
Recommended battery	*Ah(Amp)*	60(300)	60(300)	60(300)	60(300)	60(300)	60(300)
Max. intake vacuum	*KPa*	4.5	5	5	5.5	5.5	6
Max. exhaust back pressure	*KPa*	6.5	7.3	7	7.8	7.5	8.4
Quantity of air for combustion	*m³/h*	31	37	35	42	41	49
Dry weight	*Kg*	45	45	46.5	46.5	48	48
Maximum non-continuative slant (continuative)	*PTO side*	45°(35°)	45°(35°)	45°(35°)	45°(35°)	45°(35°)	45°(35°)
	Pulley side	35°(30°)	35°(30°)	35°(30°)	35°(30°)	35°(30°)	35°(30°)
	Right side	40°(30°)	40°(30°)	40°(30°)	40°(30°)	40°(30°)	40°(30°)
	Lato sinistro	45°(30°)	45°(30°)	45°(30°)	45°(30°)	45°(30°)	45°(30°)
Casing oil capacity	*l.*			1.3			
Diesel fuel tank capacity	*l.*			5			
Max axial load on drive shaft (non continuative)	*Kg*			300			

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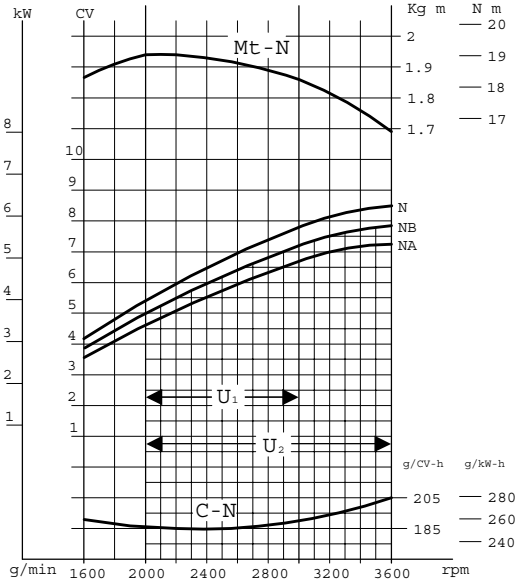
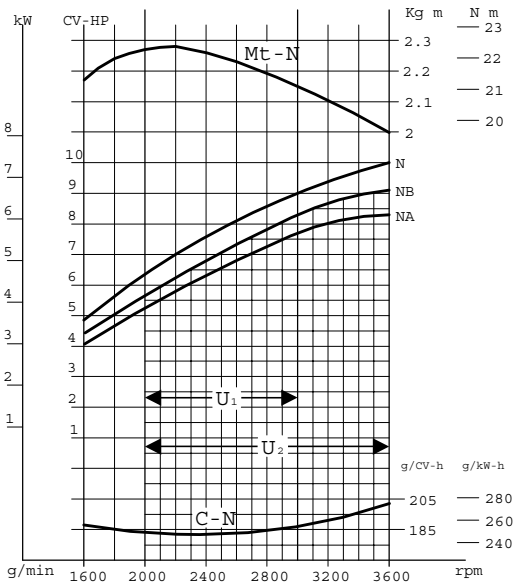
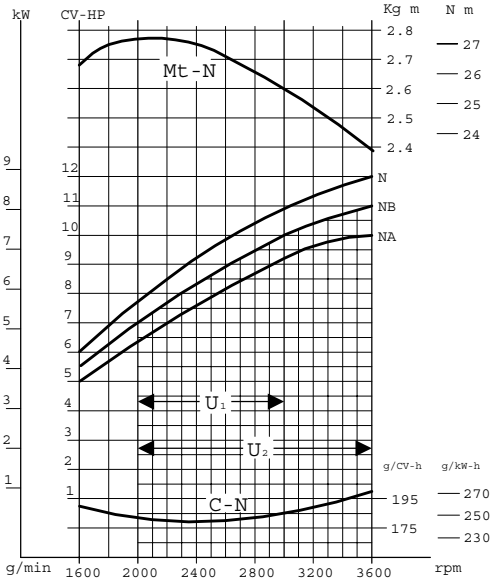
2. POWER GRAPHS



RY85.0 - RY85.1



RY100 - RY101



RY120 - RY121

N: Power for automotive service (DIN 70020)
NB: Non-overloadable power (DIN 6271)
NA: Continuative overloadable power (DIN 6271)
U1: Normal field of use, 3,000 rpm engine rate
U2: Normal field of use, 3,600 rpm engine rate
Mt-N: Torque rate corresponding to curve N
C-N: Specific consumption with reference to curve N

With ambient temperatures exceeding 20°C (+68°F) or altitudes above sea level, the engine sustains a 2% power loss for every 5°C temperature increase and 1% for every 100 meters of increased altitude.

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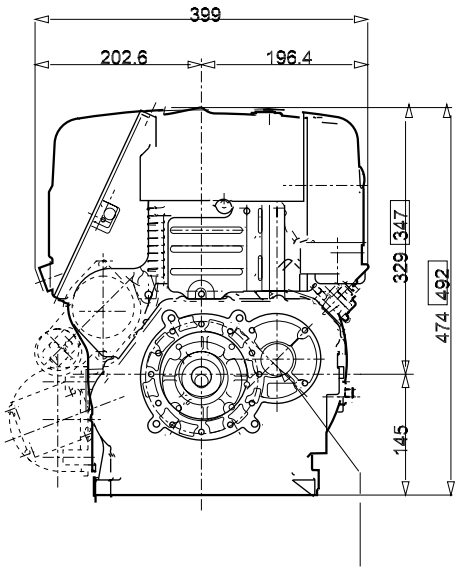
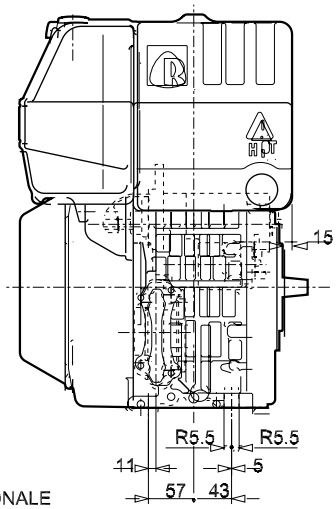
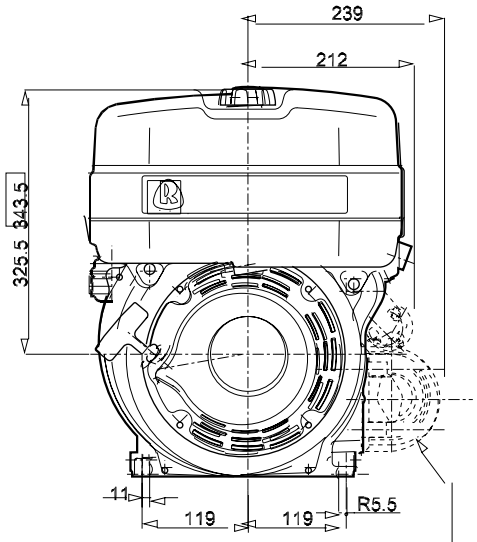
3. OVERALL DIMENSIONS





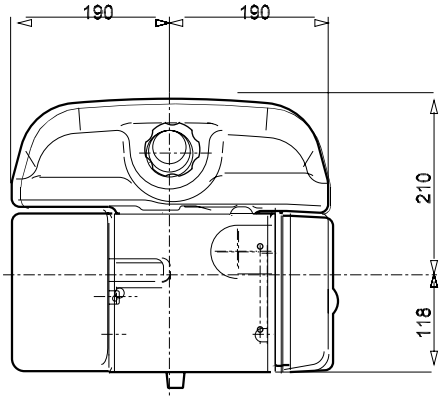
PRESA DI FORZA SU ALBERO A CAMME OPZIONALE
SENSO DI ROTAZIONE DESTRO

OPTIONAL P.T.O. ON CAMSHAFT WITH
CLOCKWISE DIRECTION OF ROTATION



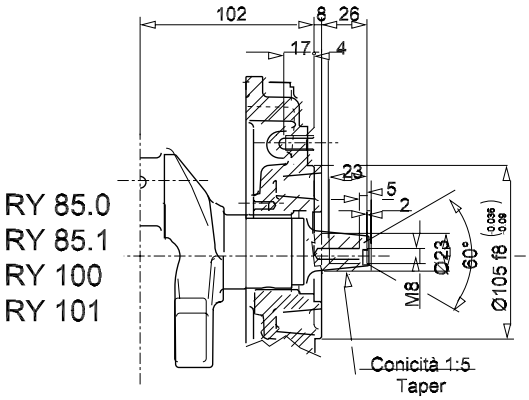
PRESA DI FORZA AUSILIARIA PER
POMPE OLEODINAMICHE (OPTIONAL)

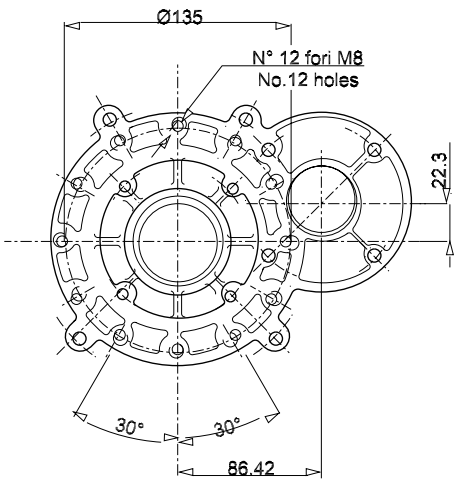
AUXILIARY P.T.O. FOR HYDRAULIC PUMPS

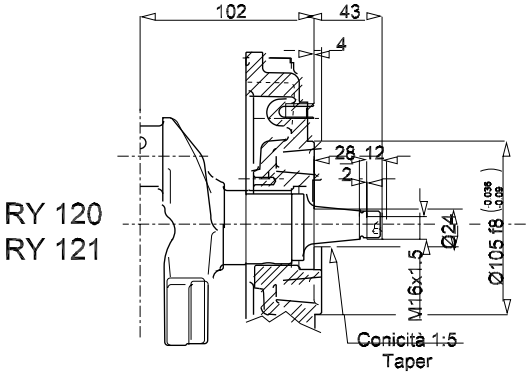


LE QUOTE NEL RETTANGOLO SI RIFERISCONO
AL MOTORE RY120

DIMENSIONS WITHIN RECTANGLES
REFFERS TO RY120 ENGINE







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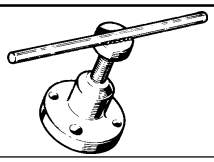
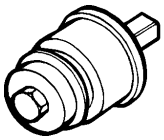
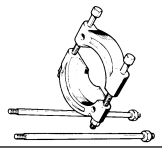
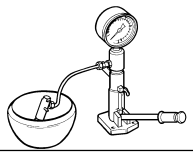
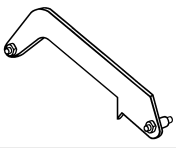
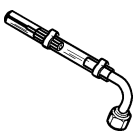
4. SPECIAL TOOLS

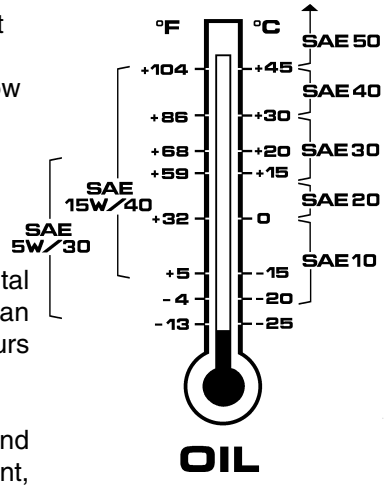
TOOL	CODE	DESCRIPTION
	365.02	Flywheel puller (also used for RD series engines)
	365.90	Tool to mount and demount main bearings (also used for MD series engines)
	366.22	Plug to mount and demount main bearings
	366.23	Sleeve to insert main bearings
	365.77	Piston mounting tool
	365.10	Crankshaft gear puller (also used for series RD engines)
	366.21	Punch to insert By-pass valve
	365.43	Injector test bench
	366.24	Tool to stagger injection lead
	365.94	Capillary tube for injection lead

5. MAINTENANCE SCHEDULE

	OPERATION	8	50	100	200	500	2500
CHECKING	Air filter oil level (for engines with wet air filters)	■					
	Engine block oil level	■					
	Battery fluid level		■				
	Rocker arm valve play				■		
	Injector calibration					■	
CLEANING	Air filter	■					
	Cylinder and head fins			■			
	Fuel tank					■	
	Internal oil filter			■			
	Injectors					■	
REPLACEMENT	Air filter oil (for engines with wet oil filters) [*]		■				
	Engine block oil [*]		▒	■			
	Air filter cartridge				■		
	Fuel filter			■			
	Dry air filter				■		
	General overhaul						■

[*] Use oil for Diesel engines according to MIL-L-2104D specifications with detergent degree S.3 (MIL-L-45199B) type AGIP SUPERDIESEL MULTIGRADE 15W/40.
use SAE 5W/30 oil if the engine operates in places where the temperature is below

(▒) First oil change.



The maintenance operations refer to engines that operate in normal environmental conditions (temperature, degree of humidity, degree of dust in the environment) and can sensibly vary, depending on the type of use (the air filter oil must be changed every 4-5 hours in dusty places).

Overhauls include : grinding the valve housings and guides, overhauling the injector and injection pump, inspection of the injector protrusion, cylinder and piston replacement, replacement of the main bearings.

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6. TROUBLESHOOTING TABLE

DEFECT / PROBABLE CAUSE	Fails to start	Starts and stops	Poor efficiency	Blocked	Noisy	Blue smoke	White smoke	Black smoke	Knocks cas.zone	Spark pings	Hunts	Consumes oil	Oil lev. inc.	Disch. oil/exhaust	Disch. oil/air fil.	Heats	Misfires	Does not accel.
Air filter clogged		●	●															
Con rod small end with excessive play										●								
Engine running in														●				
Unsuitable fuel	●									●							●	●
Air intaken by injection pump	●	●															●	●
Fuel filter clogged		●	●															
Fuel tank empty	●																	
Worn main bearing				●														
Clearance insufficient										●						●		
Clearance excessive	●		●				●						●					
Timing system gears defective					●													
Head and cylinder fins clogged																●		
Valve guides worn						●						●						
Piston seized			●	●		●						●						
Cylinder worn			●			●						●						
Excessive rocker arm play					●					●								
Regulator spring defective											●							
Pipe clogged	●	●																
Incorrect injection lead		●	●				●			●						●		
Injection pump defective	●												●					
Injection pump valve defective			●														●	
Intake valve without play															●			
Injector defective		●	●					●					●			●		
Injector with clogged holes		●	●															
Oil splash guard seals defective												●						
Exhaust valve burnt out		●	●															
Worn main or big-end bearing									●									
Excessive load								●								●		
Regulator lever with too much play											●							
Tank plug hole blocked		●																
Too much oil in casing						●						●						
Hardened injection pump lever											●							●
Worn piston rings			●			●						●						
Slack pump delivery union			●										●				●	
Engine cold																	●	
Low idling rate														●				
Change rate insufficient											●							

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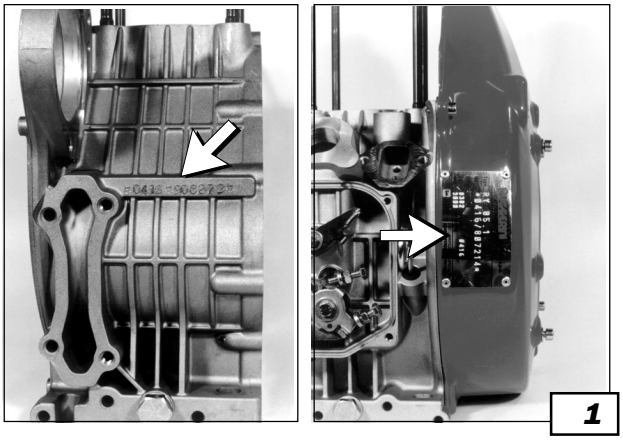
7. ENGINE IDENTIFICATION

The type of engine and serial number are stamped on the crankcase and on the data plate affixed to the conveyor (fig. 1).

Always indicate these engine identification numbers when ordering spare parts or making requests under guarantee.

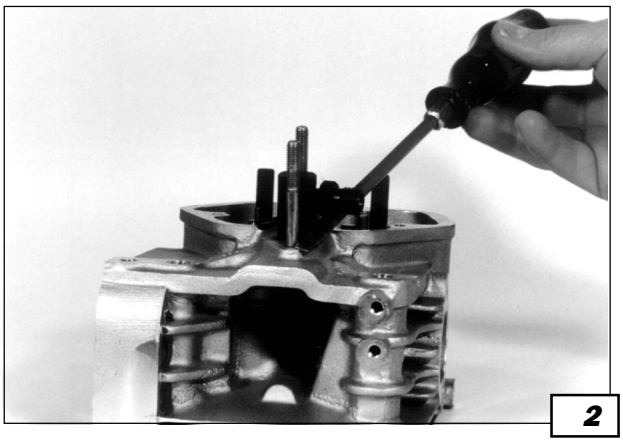


1

8. DEMOUNTING THE ENGINE

8.1 Removing the injector

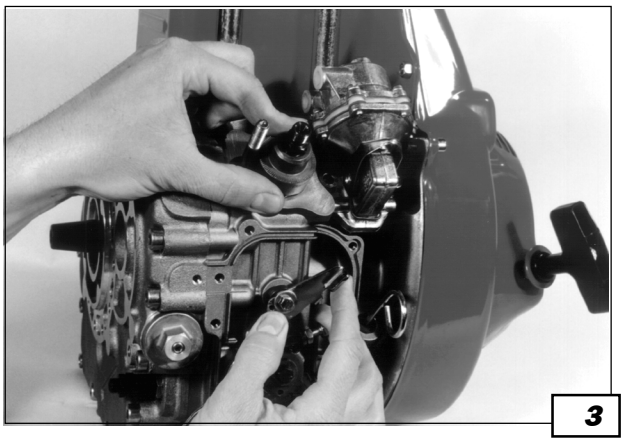
Slacken off the fuel delivery pipe, remove the fixing bracket and take out the tube.
Remove the injector by levering it out with a screwdriver, as indicated in fig. 2.



2

8.2 Removing the injection pump

Mark the position of the injection pump in relation to the engine casing (if this has not already been done).
Remove the injection tube and take out the fuel pipes.
The pump can only be removed when the stop lever has been turned to the stop position. To do this, the pump must be pressed towards the housing as shown in fig. 3.

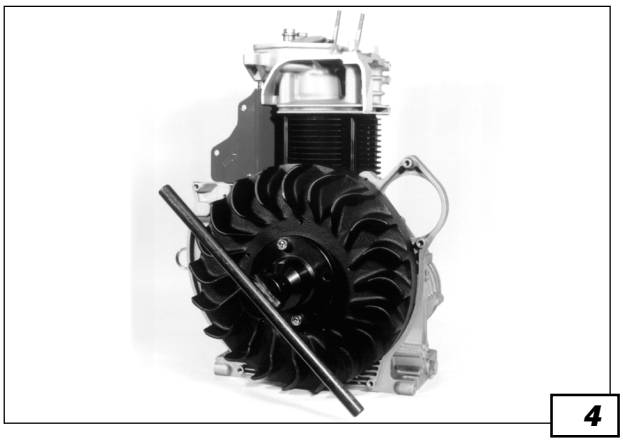


3

8.3 Removing the flywheel

Remove the fuel tank, the air conveyor and flywheel nut.
Remove the flywheel using puller code 365.02 as indicated in fig. 4.

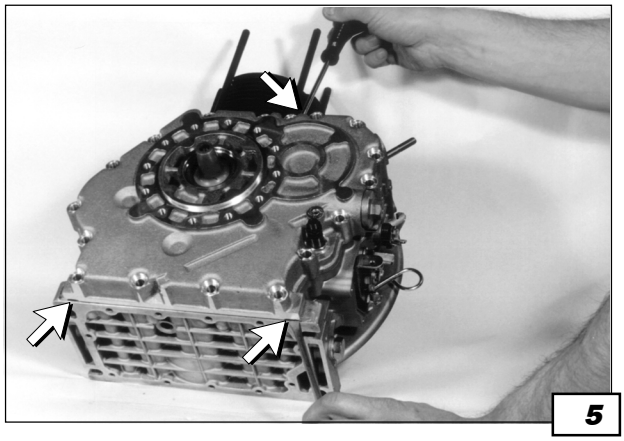
WARNING: do not strike the puller in an axial direction during this operation.



4

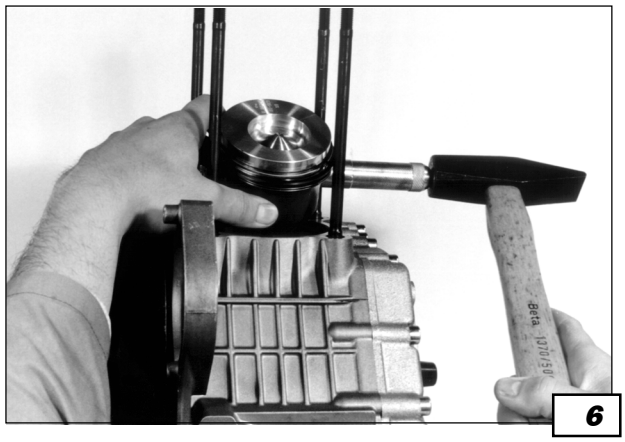
8.4 Removing the cover on the timing system side
Slacken off the screws around the perimeter of the cover on the timing system side. Split the cover from the engine casing by levering with a screwdriver in the points indicated in fig. 5.

Warning: to prevent damage to the main bearings, it is advisable to demount the cover from the timing system side with the engine cold.


5

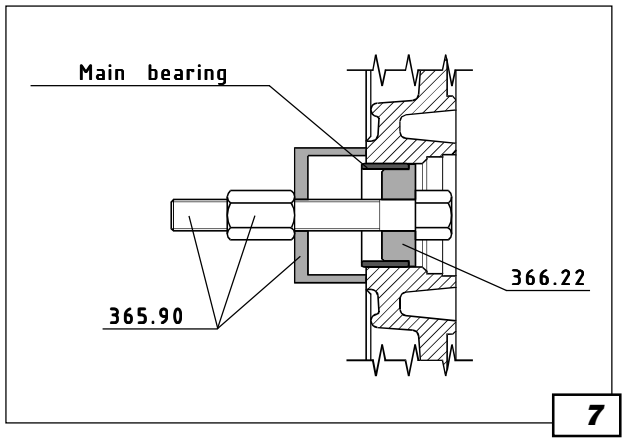
8.5 Demounting the piston
Take out the piston pin as shown in fig. 6.

Warning: do not demount the head when hot or the retention surfaces could be damaged.


6

8.6 Demounting and remounting the main bearings
Use tool code 365.90 and plug code 366.22 (fig. 7) to demount the main bearings from the engine casing and cover on the timing system side.
To fit the main bearing back into the engine casing, use tool code 365.90 with plug code 366.22 and sleeve code 366.23 side A (fig. 8).
To mount the main bearing on the cover on the timing system side, use tool code 365.90 with plug code 366.22 and sleeve code 366.23 side B (fig. 8).

During the assembly operations, make sure that the bearing holes match the oil ducts by making reference marks with a felt-tip pen.
Make sure that the reference mark on the bearing edge points towards:
- the casing interior
- the outer part of the timing system cover.

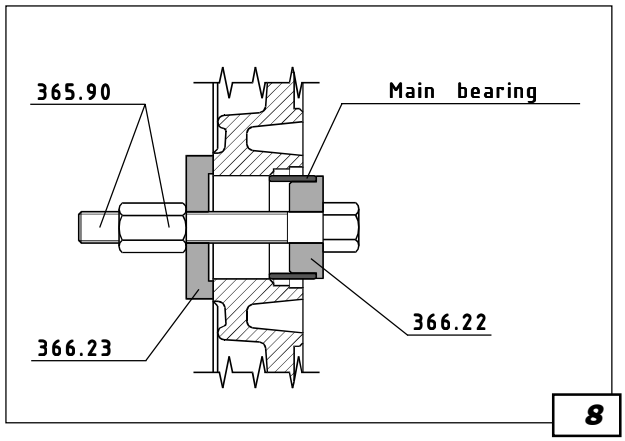


7

WARNING
Proceed with the following inspections after assembly:

Cover on timing system side
The main bearing must project **1.7 to 2 mm** in relation to the bearing surface of the bull ring (inner side of cover).

Engine casing
The main bearing must be flush with the bearing surface of the shimming ring (inner side of casing).



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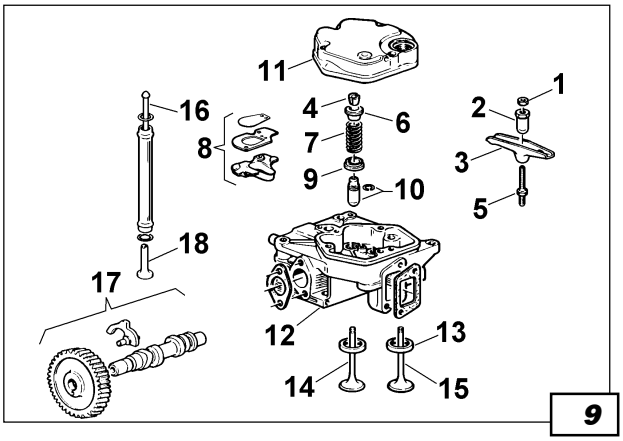
9. INSPECTIONS AND OVERHAULS

9.1 Head

Parts indicated in fig. 9.

1. Nut - 2.Nut with ball - 3. Rocker arm - 4. Cotters - 5. Rocker arm stud - 6. Upper cap - 7. Spring - 8. Air-relief valve - 9. Lower cap - 10. Valve guide - 11. Rocker arm cover - 12. Head - 13. Valve housing - 14. Exhaust valve - 15. Intake valve - 16. Rocker arm rod - 17. Camshaft - 18. Tappets.



9

The head is made of aluminium with valve guides and housings in faced cast iron.

Do not demount the head when hot to avoid deformations.

remove any carbon deposits from the head and check the cylinder bearing surface. Level it off to a depth of no more than 0.3 mm if deformed.

The head must not be cracked or deformed. If such faults are discovered, replace the part after consulting the spare parts catalogue.

9.2 Valves - Guides - Housings

Clean the valves with a metal brush and replace them if the tops are deformed, cracked or worn.

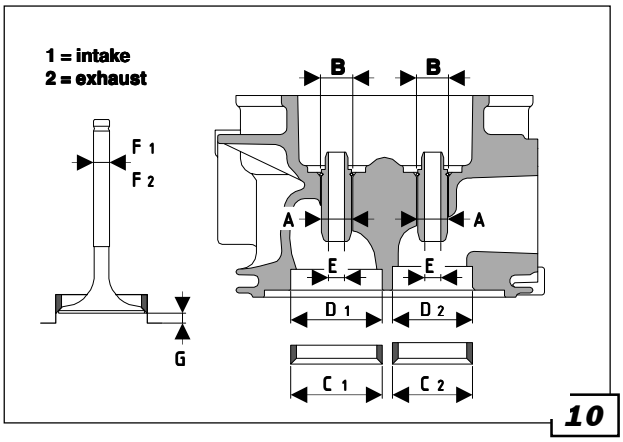
RY85.0 - RY85.1

øA	øB	øC1	øC2	øD1	øD2	øE(*)	øF1	øF2	G
13 to 13.01	13.025 to 13.037	36.630 to 36.645	33.630 to 33.645	36.5 to 36.525	33.5 to 33.525	7 to 7.01	6.96 to 6.97	6.945 to 6.955	0.8 to 1

RY100 - RY101 - RY120 - RY121

øA	øB	øC1	øC2	øD1	øD2	øE(*)	øF1	øF2	G
13 to 13.01	13.025 to 13.037	40.13 to 40.145	35.13 to 35.145	40 to 40.025	35 to 35.025	7 to 7.01	6.96 to 6.97	6.945 to 6.955	0.8 to 1

(*) with guide mounted. measurements in mm



10

Check the dimensions of the valve stem (fig. 11) and the play between the guide and valve. Ream the guide to the dimensions indicated in the table. Change the guide and valve if the play exceeds 0.1 mm.

The valve housings will always need to be ground when new guides are mounted. Valve guides oversized on the outside by 0.10 mm are available.

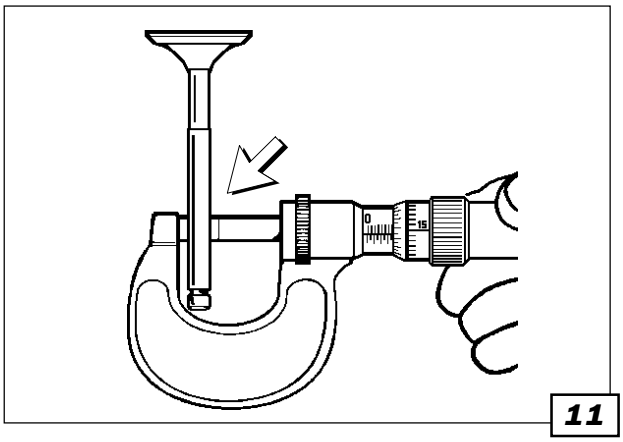
After the engine has been used for a lengthy period of time, valve knocking in their housings at high temperatures will harden the housing tracks and make manual milling difficult to carry out.

When this happens, remove the hardened surface layer with a grinder at 45° (Fig. 12).

The valve retention track will widen when the valve housing is machined. Final adaptation of the valve in the housing must be carried out by smearing fine grain lapping compound in the housing and turning the valve with a light pressure and with an alternate movement until the surfaces bed perfectly (fig. 13).

Comply with the valve embedding values as indicated in the table (G, fig. 10).

Warning: when the valve embedding values are lower than those prescribed, the valves could interfere with the piston.



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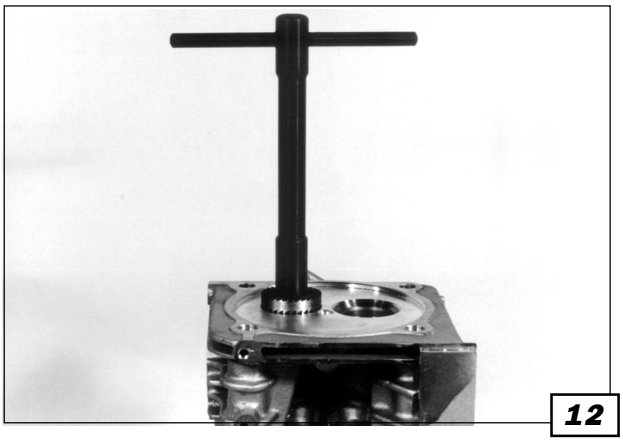

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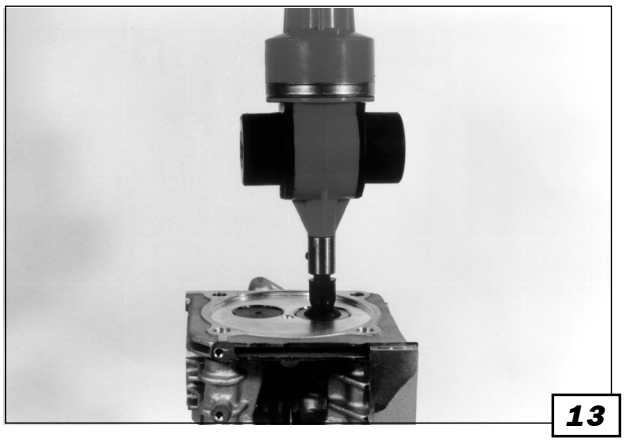
Grinding-in must always be carried out when new valves or housings are mounted. Valve housings oversized on the outside by 0.5 mm are available.
Thoroughly wash the valve and housing with petroleum or gasoline to eliminate lapping paste residues or swarf.
Proceed in the following way to make sure that the valve and seat are tight:

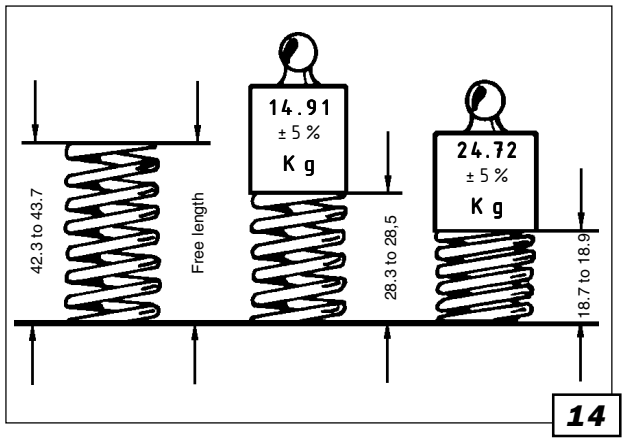
1) Mount the valve on the head with cap string and cotters (see fig. 9)
2) Overturn the head and pour a few drops of diesel fuel or oil on to the edge of the valve top
3) Blow compressed air into the head duct. Plug the edges of the duct itself to prevent air escaping.

If there are air leaks in the form of bubbles between the housing and valve, demount the valve and grind-in again.


13

9.3 Valve springs

Check the length of the spring as indicated in fig. 14 to identify any yielding.
Replace the springs if the values are different.



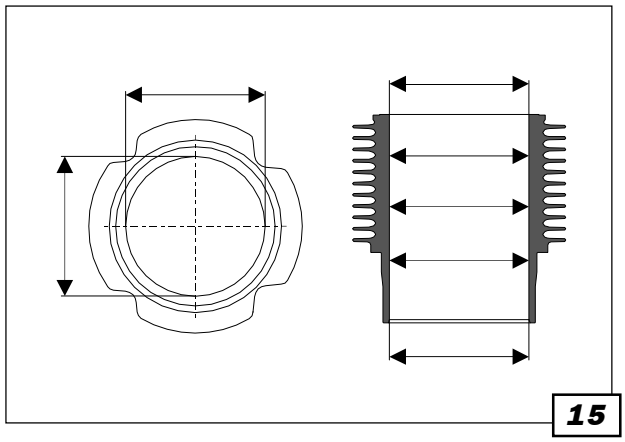
14

9.4 Rocker arms

Make sure that there are no evident signs of wear on the contacting surfaces. Replace the parts if necessary.

9.5 Cylinder

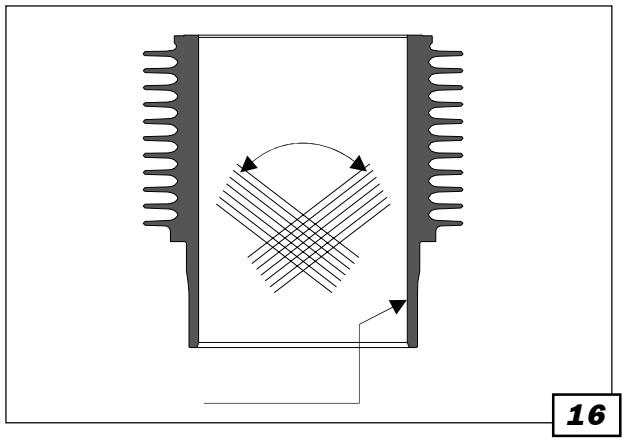
In special cast iron with integral liner. Use a bore gauge to check the two internal diameters **(C-D)** perpendicular to each other and at different heights (fig. 15). Maximum tolerated taper error **(A-B)** and ovality error **(C-D)**: 0.06 mm.


15

Cylinder diameter:

RY85.0 - RY85.1	Ø 80 to 80.020
RY100 - RY101	Ø 85 to 85.020
RY120 - RY121	Ø 87 to 87.020

Just replace the piston rings if the cylinder diameter does not exceed the values above or if the cylinder is slightly scored on the surface. In this case, to ensure that the piston rings and cylinder adapt to each other as soon as possible, restore liner roughness by passing 80 to 100 grain emery cloth soaked in diesel fuel and wound around the palm of the hand over its inner surface (fig. 16) until this appears cross-hatched. Follow these operations by thorough washing in gasoline or petroleum. Replace the cylinder and piston if there is a ridge in zone "X" fig. 16 of the cylinder and if tapering and ovality exceed the previously given values.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9.6 Piston rings - Piston - Pin

To gauge the wear on the piston rings, put them into the cylinder from the bottom side and measure the distance between the free ends (fig. 17), which must be:

Piston ring	Assembly mm	Wear limit mm
Compression	0.30 to 0.50	0.80
Oil scraper	0.25 to 0.50	0.80

Make sure that the piston rings slide smoothly in the slots and use a thickness gauge to check the play between the slot and ring (fig. 18). Replace the piston and rings if the play exceeds:

Piston ring	Limite di usura mm
1st Compression	A = 0.22
2nd Compression	B = 0.19
3rd Oil scraper	C = 0.16

WARNING: it is advisable to replace the piston rings whenever the piston is demounted.

Checking the piston diameter:
the diameter of the piston must be measured at a distance from the base (fig. 19) of approximately:
10 mm (for RY85.0 - RY85.1 - RY100 - RY101 series engines
11 mm (for RY120 - RY121) series engines

Engine	Diameter mm
RY85.0 - RY85.1	79.915 to 79.935
RY100 - RY101	84.915 to 84.935
RY120 - RY121	86.915 to 86.935

Check the play between cylinder and piston. Replace the parts if play exceeds 0.150 mm.
Play between pin and piston mm:

Pin Ø mm	Play mm	Wear limit mm
21.997 to 22.002	0.003 to 0.013	0.040

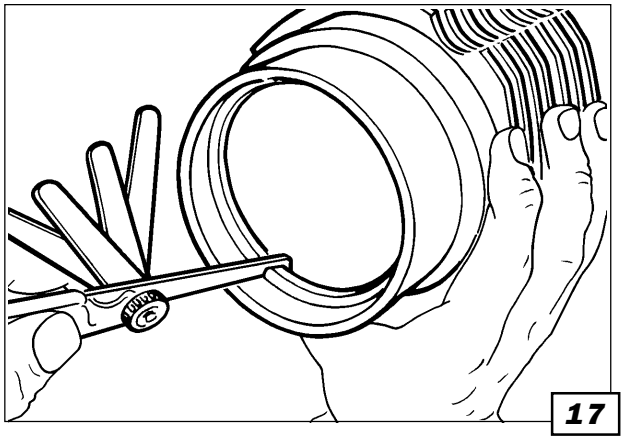
9.7 Connecting rod

Coupling between the small end hole of the connecting rod and pin is made without a bearing.
Play between connecting rod small end and pin mm:

Pin Ø mm	Play mm	Wear limit mm
21.997 to 22.002	0.023 to 0.038	0.070

Check connecting rod axes parallelism in the following way:

1) Insert the pin into the small end hole of the connecting rod and a calibrated plug into the big end (with the bearing mounted).
2) Rest the plug on two prisms arranged on a surface plate or between two centers (fig. 20).
3) Use a centesimal comparator to check that the difference between the readings made at the ends of the pin does not exceed **0.02 mm**. square up the connecting rod if the deformation is greater **(max. 0.05 mm)**.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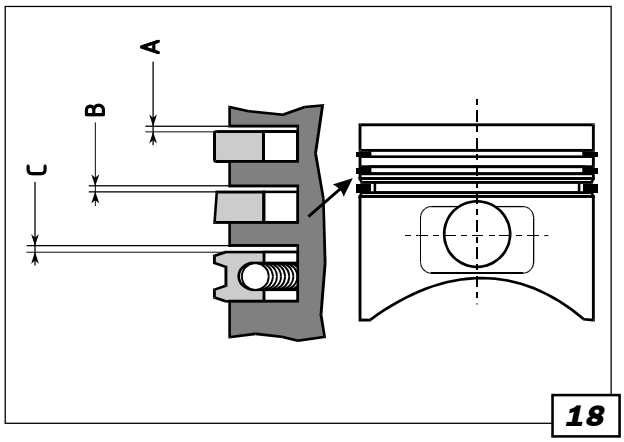

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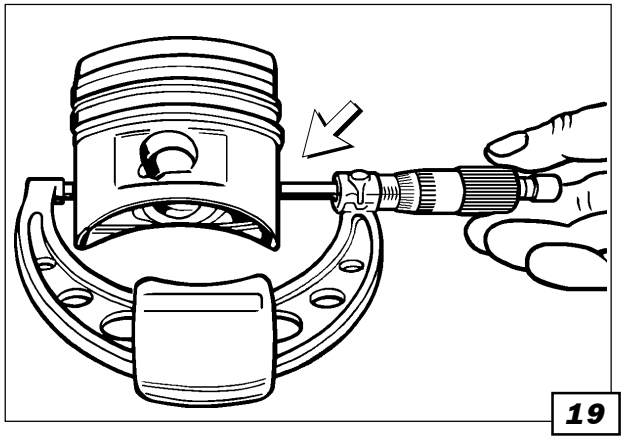
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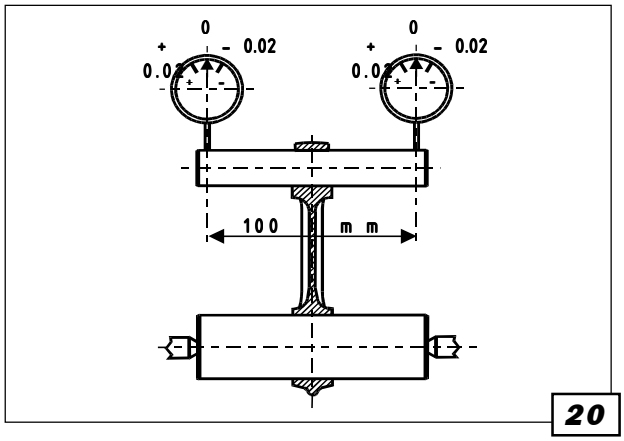
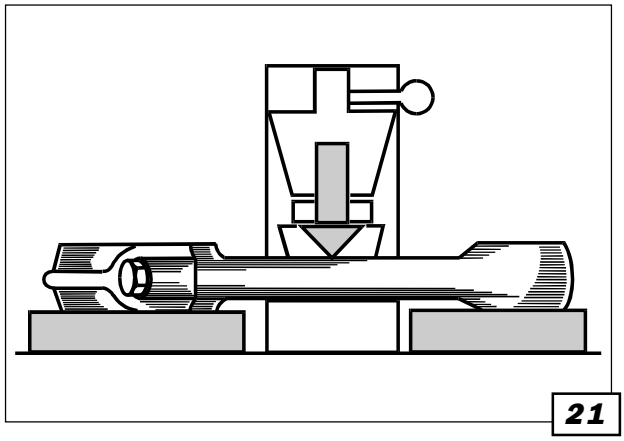


20

The operation is carried out by applying a calibrated pressure to the convex side in the middle of the connecting rod stem set on surface plates (fig. 21).


21

9.8 Crankshaft

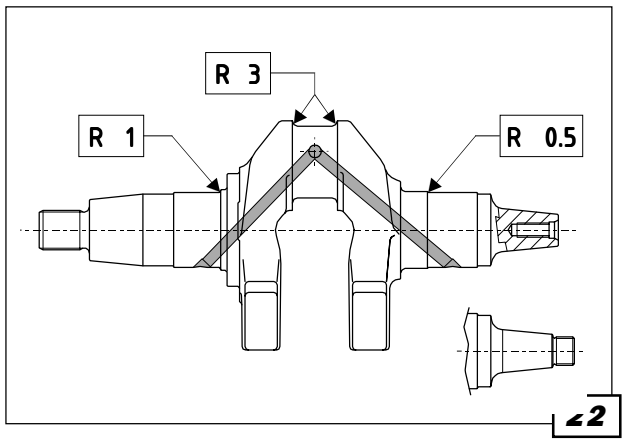
It is advisable to check the condition of the crankshaft whenever the engine is demounted and particularly when cylinders and pistons must be replaced following wear due to dust having been intaken.
Thoroughly clean inside the oil ducts using a shaped metal point.
If there are heavily caked incrustations, immerse the crankshaft into a bath of petroleum or gasoline before proceeding with the scraping operation (fig. 22).

When the crankshaft is perfectly clean, check with a micrometer to ascertain wear and main journal ovality in the two perpendicular positions (fig. 23).

Grind the shaft if the wear exceeds the values in the table by **0.08 mm** or more.

Dimension	STD mm	-0,25 mm
A C	41.97 to 41.99	41.72 to 41.74
B	39.98 to 40	39.73 to 39.75

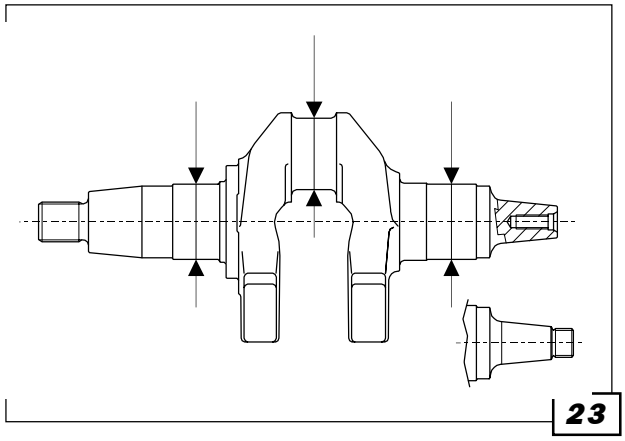
NOTE: crankshaft grinding operations of more than 0.25 mm should not be carried out.



22

Undersized bearings can be mounted without any reaming work required.

WARNING: do not remove material from the main journal shims during the grinding operation as this would alter crankshaft float. Also make sure that the grinder radii correspond to those indicated in fig. 22 to prevent fracture sections from initiating on the shaft.

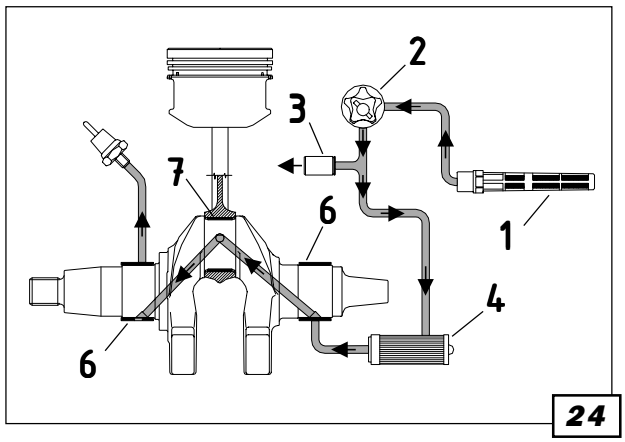

23

9.9 Oil retention rings

Make sure that the rings have not hardened in the retention lip and that there is no sign of breakage or wear.

9.10 Lubrication circuit

Lubrication of the main bearings and connecting rod big end is the forced type with a rotor oil pump.
Excessive pressure in the oil circuit is prevented by the by-pass valve (3, fig. 24).
All the other parts are splash lubricated.
Oil vapours are eliminated from inside the casing by a diaphragm mounted in the rocker arm cover.



24

Illustration in fig. 24:

1. Internal intake oil filter in casing - 2. Oil pump - 3. By-pass valve - 4. Engine oil filter - 5. Pressure switch - 6. Main bearing - 7. Big end bearing.

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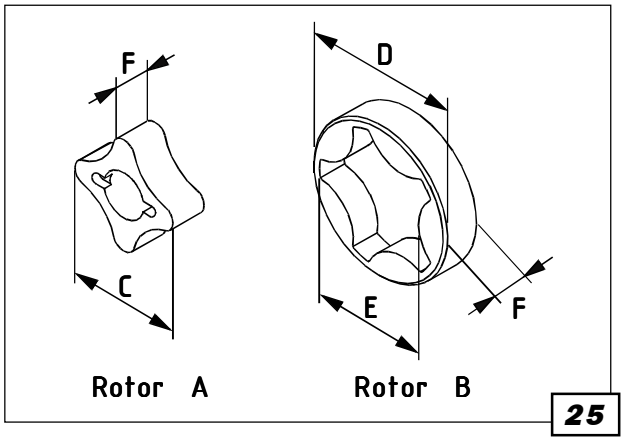
9.11 Checking the oil pump

Make sure that the oil pump cover is in a good condition. After demounting, examine the rotors and replace them if their lobes or centerings are damaged. To check the degree of pump wear, measure the dimensions of rotor **A** and rotor **B** (fig. 25) and compare them with the values in the following table:

OIL PUMP ROTOR DIMENSIONS AND PLAY

	Assembly mm	Limite usura mm
C	Ø25.97 to 25.99	Ø25,92
D	Ø34.96 to 34.99	Ø34,87
E	26.205 to 26.27	26,31
F	7.97 to 7.99	7.93



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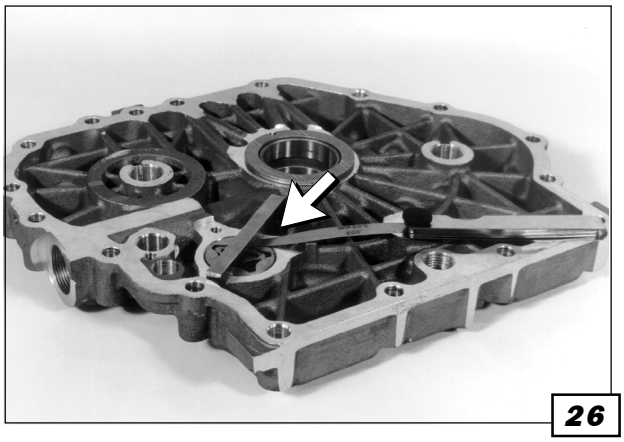
The entire pump must be replaced if the wear is greater.

The coupling play between the external oil pump rotor and the housing on the cover of the timing system is:

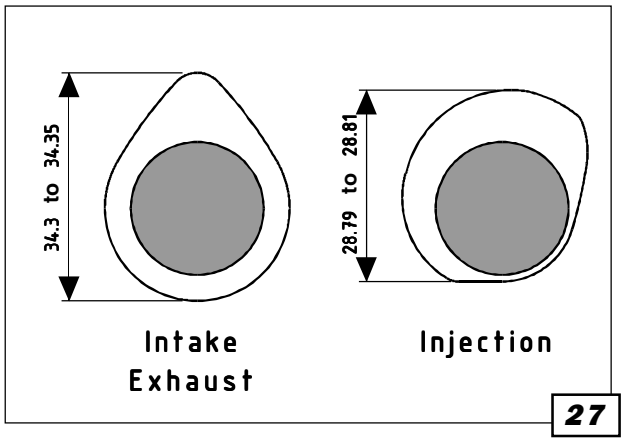
Assembly mm	Limite di usura mm
0.16 to 0.215	0.345


26

Make sure that the oil pump recess in relation to the surface of the timing system cover (fig. 26) is between :

Assembly mm	Wear limit mm
0.03 to 0.07	0.11

Make sure that there are no impurities in the by-pass valve on the cover on the timing system side by unscrewing the inspection plug near the fuel flow limiter.



27

9.12 Camshaft

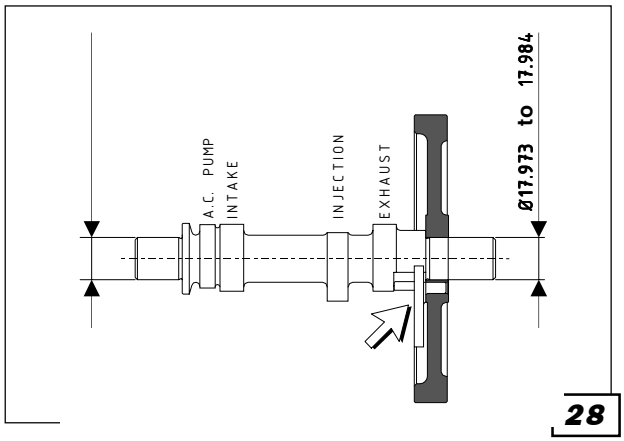
Make sure that the cams and bearing pins are not scored or worn. Check the dimensions as indicated in fig. 27.

Check the dimensions of the camshaft pins (D, fig. 28) and the corresponding housings in the casing and cover on the timing system side. The max. xonstructional play is 0.032 to 0.061 mm.

WARNING: replace the shaft if the wear on the cams or pins exceeds:

0.1 mm (injection cams and pins)
0.3 mm (intake and exhaust cams)

NOTE: make sure that the valve lifting mechanism (fig. 28, A) is not damaged and that there is nothing to hinder its movement.



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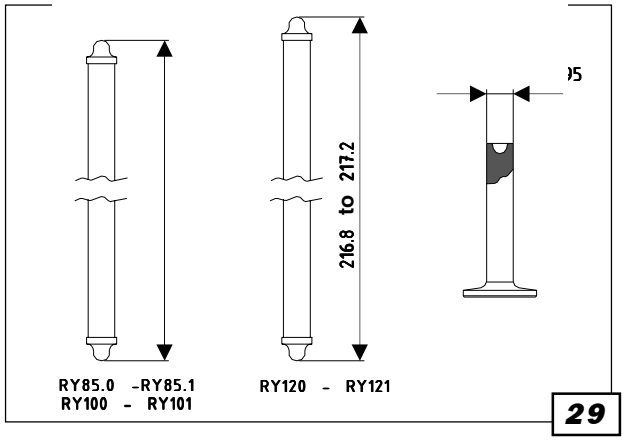
9.13 Tapets and rocker arms

Make sure that there is no wear, scoring or signs of seizure on the surfaces of the tappets (fig. 29). Replace the parts if necessary.

Tapet and housing coupling play:

Assembly mm	Limite di usura mm
0.005 to 0.029	0.10

The rods must be straight with ball shaped surfaces at the ends and in good conditions (fig. 29).



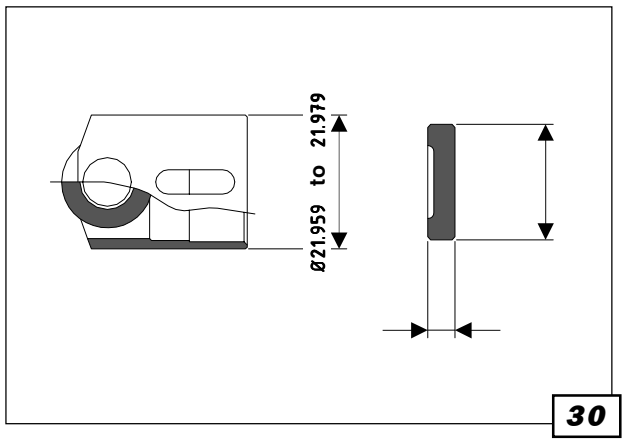
29

9.14 Injection pump tappets and pads

Replace the parts if the wear on their surfaces exceeds 0.1 mm (fig. 30).

Coupling play between the tappet and relative housing in the crankcase:

Assembly mm	Wear limit mm
0.021 to 0.059	0.10



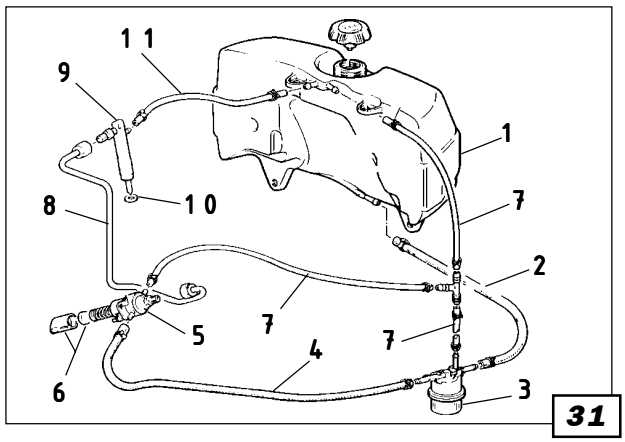
30

9.15 Fuel pump (optional)

Check the projection of the A.C. pump rod in relation to the engine casing surface with the canshaft eccentric in the non-operative position.

Rod length mm	Wear limit mm	Rod projection mm
53.0 to 53.2	0.3	1.45 to 2.05

WARNING: the rod projection cannot be adjusted.



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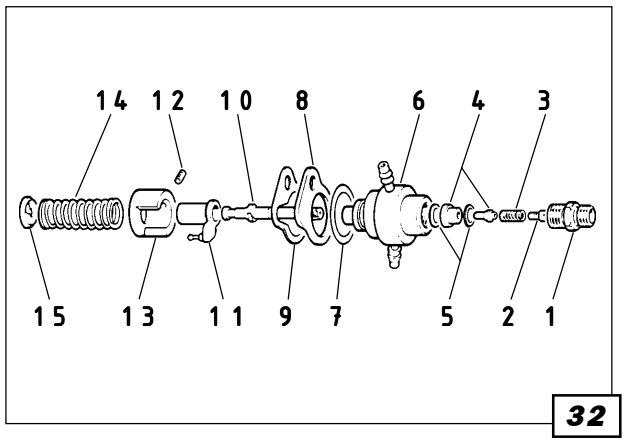
10. INJECTION COMPONENTS

10.1 Fuel circuit

Fuel supply is the gravitational type. An AC pump can be mounted on request. Air bleeding is automatic.

Illustration in fig. 31:

1. Fuel tank - 2. Fuel pipe - 3. Fuel filter - 4. Fuel pipe - 5. Injection pump - 6. Injection pump tappet - 7. Bleed tubes - 8. Injection pipe - 9. Injector - 10. Washer - 11. Fuel return pipe.



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10.2 Injection pump

Illustration in fig. 32:

1. Delivery union - 2. Filler - 3. Valve spring - 4. Delivery valve - 5. Washers - 6. Monobloc pump casing - 7. Adjuster seal - 8. Flange - 9. Pump seal - 10. Plunger - 11. Adjuster sleeve - 12. Plug - 13. Adjuster block - 14. Spring - 15. Lower cap

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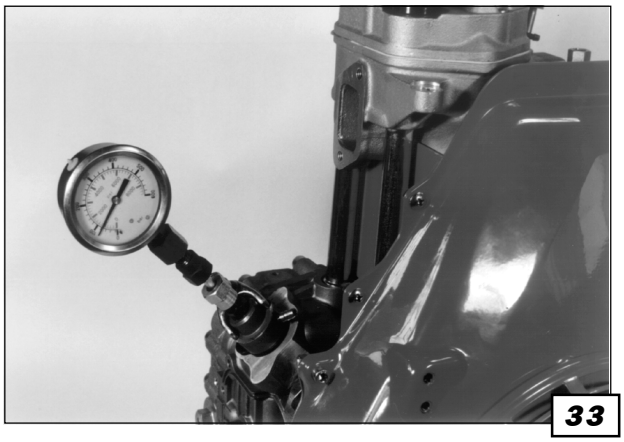
10.3 Checking the injection pump

before demounting the injection pump, make sure that the plunger unit, enbloc pump casing and valve are pressure tight by proceeding in the following way:

1) Connect a pressure gauge with scale up to **600 Kg/cm²** to the fuel delivery pipe (fig. 33).
2) Set the regulating sleeve (fig. 34) to the average delivery position.
3) Slowly turn the flywheel to make the plunger make one compression stroke.
4) Read the indication on the pressure gauge. If it is lower than **300 Kg/cm²**, the complete pump must be changed.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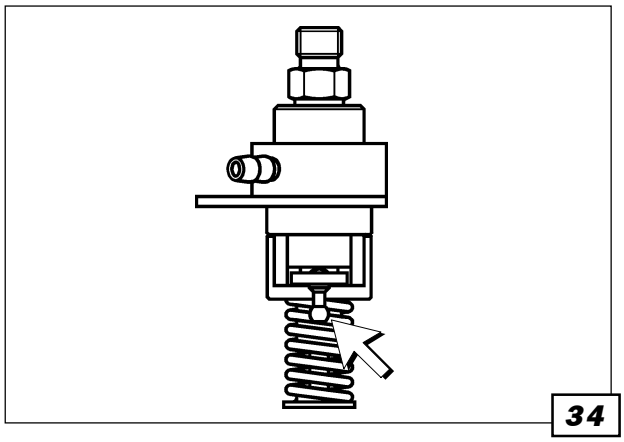
During the test, the pressure gauge needle will show a progressive pressure increase until reaching a maximum value, after which it will drop sharply back and stop at a lower pressure value. Replace the valve if the pressure drop is more that **50 Kg/cm²** and continues to slowly drop lower.
The pressure must drop from **200 Kg/cm²** to **150 Kg/cm²** in not less than **7 sec.**

10.4 Injection pump calibration (fig. 35)

When the adjuster sleeve is **10.5 mm** from the stop position and the pump spins at **1,500 rpm**, the amount of fuel for **1,000** deliveries must be between:

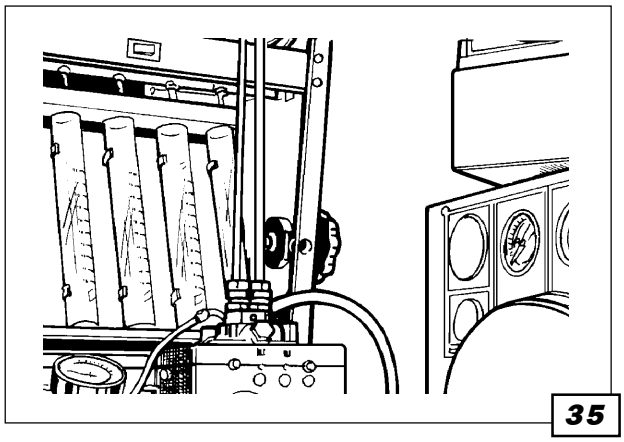
23 to 25 cc

Replace the pump if the values differ.


34

WARNING:
Check to make sure that plunger travel with the injection cams in the non-operative position (BDC) at the start of delivery is:

1.9 to 2.0 mm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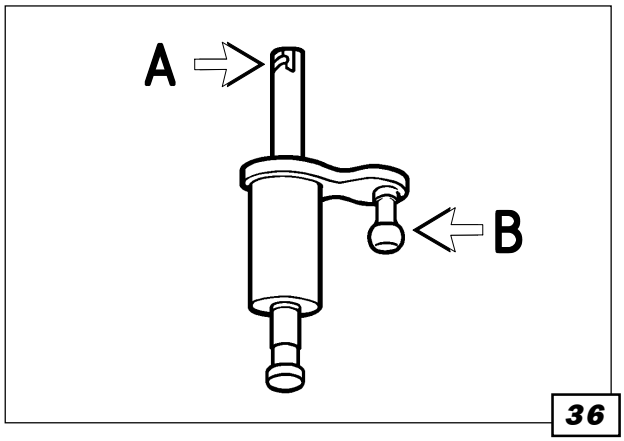
10.5 Injection pump assembly (fig. 37)

If the injection pump must be demounted, use an electric pen to mark the adjuster block (M) with the enbloc pump casing (A) and loosen the plug (N) after having heated it to make the Loctite easier to release.
Comply with the following instructions when remounting the parts:

1) Fit the washer (B), the delivery valve (C), the washer (D), the valve spring (E), the filler (F) into the enbloc pump casing (A) and torque the delivery union (G) to a value of:

4.3 to 5.4 Kgm (42.5 to 52.5 Nm)

2) Insert the adjuster seal (H).
3) Insert the flange (I).
4) Insert the plunger with helical profile (A, fig. 36) into the iner housing of the adjuster sleeve from the side opposite the sleeve pin (B, fig. 36).



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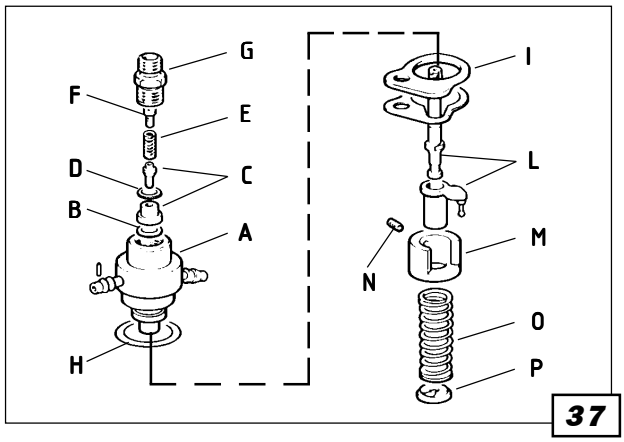
5) Insert the adjuster sleeve unit and plunger (L) into the pump casing (A), making sure that the helical profile is directed on a level with the return union with ball.
6) Fit in the adjuster block (M), matching the reference marks applied during the demounting phase.
7) Tighten the plug (N) to a **0.5 to 0.6 Nm** torque, locking it in place with Loctite 290.
8) Insert the spring (O) and lower cap (P).
9) Compress the tappets in the various operating positions to check that the adjuster sleeve (L) slides perfectly. Resistance or jamming will make the engine to hunt during operation.



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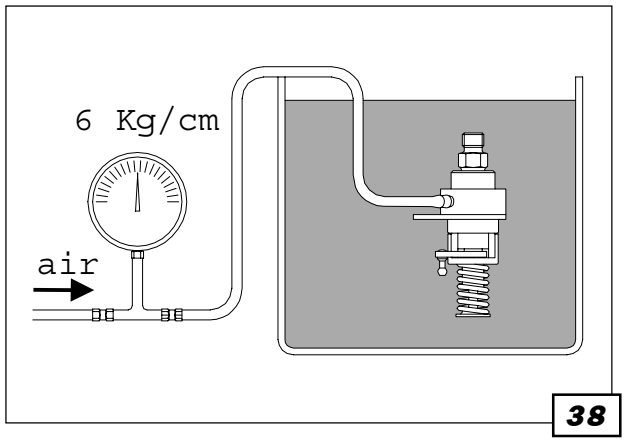
10.6 Leak test

Plug the fuel return union and let air in through the fuelling union at a pressure of **6 Kg/cm²**. Fully immerse the pump in a receptacle containing diesel fuel for about 50 - 60 seconds (fig. 38) and make sure that no bubbles appear when the tappet is compressed 53.6 mm, corresponding to the bottom dead center point during work.
NOTE: the position of the pump adjuster sleeve is of no importance for this test.



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10.7 Injector

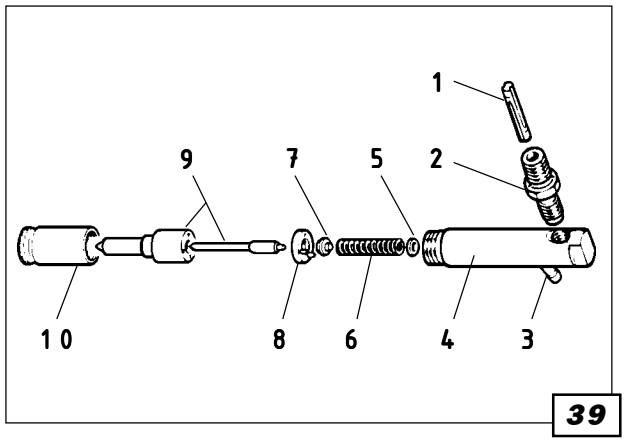
Details of fig. 39:

1. Filter - 2. Fuel inlet union - 3. Fuel return union - 4. Nozzle holder - 5. Calibration washer - 6. Spring - 7. Pressure rod - 8. Spacer - 9. Nozzle - 9. Ring nut.

10.8 Injector inspection and calibration

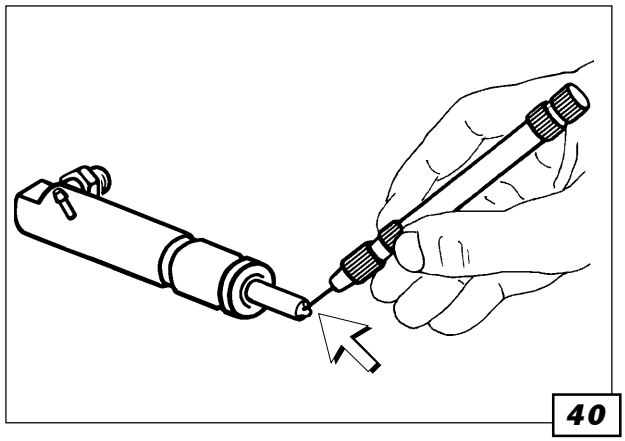
1) Clean the nozzle holes with a thin steel wire (fig. 40) with the following diameters:

Engine series	Diameter of steel wire (mm)	Number of holes	Diameter of holes (mm)
RY85.0 RY85.1	**0.21**	4	0.22
RY100 RY101 RY120 RY121	**0.24**	5	0.25



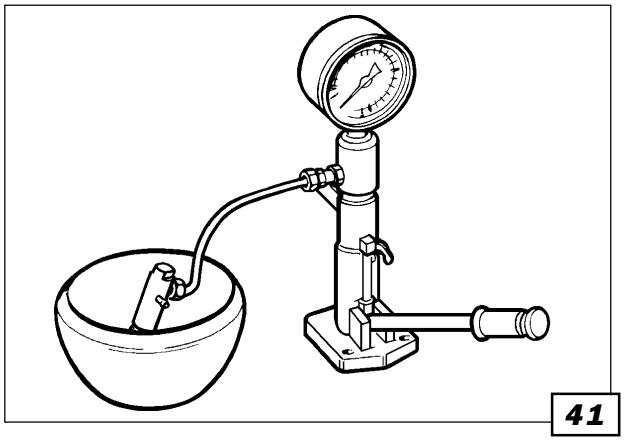
39

2) Mount the injector on the test bench (code 365.43, fig. 41). Disconnect the pressure gauge and rapidly operate the lever. The nozzle must make the characteristic "trilling" sound and inject with a good atomizing action.
3) Connect the pressure gauge. Slowly depress the level in a continuous way until injection occurs.
The injector needle must "open" at the pressure of 230 to 238 bar. Vary the washer shims (N° 5 fig. 39) to calibrate in the correct way.
4) **Leak test:** operate the test bench lever until the gauge pointer is 20 Kg/cm² below the injection pressure value. Nozzle tightness is good if no fuel comes out within 10 sec.
5) **Checking for leaks on the nozzle return phase:** operate the test bench lever until the gauge pointer is 20 Kg/cm²


40

below the injection pressure value. Release the lever and check the time it takes to drop. The pressure must drop to 150 to 100 Kg/cm² withinn 6 to 40 seconds.

- replace the nozzle if it drops in less than 6 seconds.
- if it takes longer than 40 seconds to drop, make sure that there are no carbon deposits in the nozzle and that the return holes are not clogged.

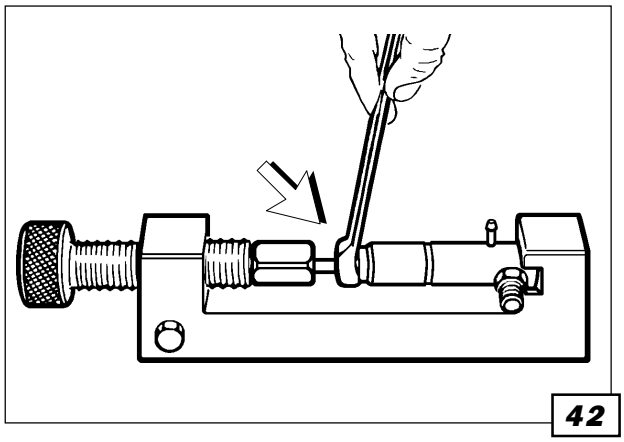


41

10.9 Demounting and remounting

Loosen the ring nut that fixes the nozzle using a torque wrench and as device like the one shown in fig. 42 which relieves the pressure exercised by the spring on the ring nut.

1) **Visual inspection:** make sure that the needle housing is not deformed or excessively rough.
   The nozzle body must not show signs of wear or damage.
   The holes must be free from carbon residues.
2) **Smoothness test**: the nozzle needle, which will have been previously immersed in impurity-free fuel, should be inserted into the body of the nozzle. Noz extract it by up to a third of the guide length, holding the nozzle in a vertical position. The needle must drop back into its housing thanks to its actual weight alone.



42

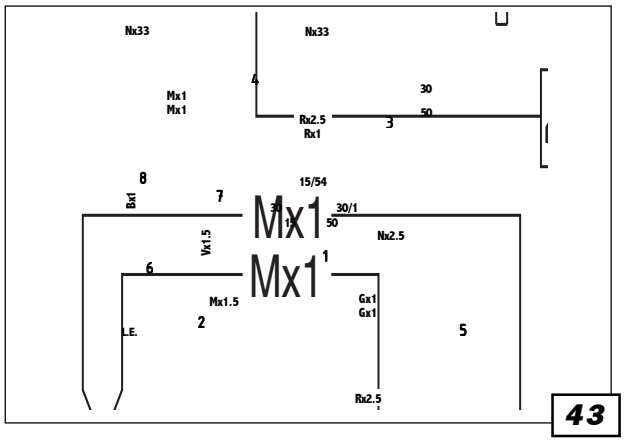
Remount the injection in compliance with the order indicated in fig. 39. Make sure that the plugs and centering pins on the spacer (N° 8 fig. 39) match the relative holes in the housings. Tighten the ring nut that fixes the nozzle to a value of:

4.6 to 5.6 Kgm (45 to 55 Nm)

11. ELECTRICAL EQUIPMENT

11.1 Characteristics of the system

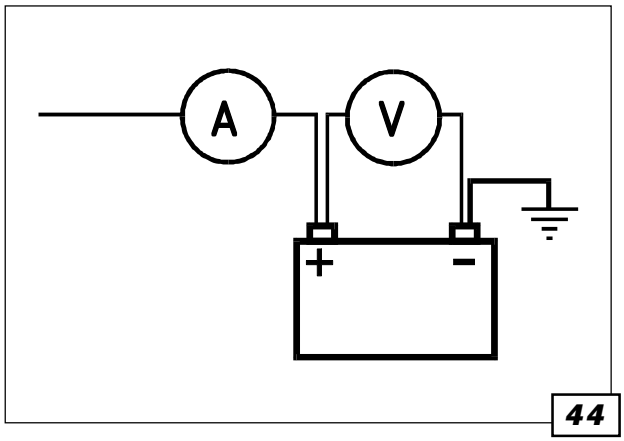
Starter motor: lh rotation direction (pinion side), 12V voltage rating, power 1.1 kW.
Internal alternator: 12V - 280W
Voltage regulator: electronic, with controlled diodes and indicator connection for battery recharger
Recommended battery: 12V 60Ah (300A).
Optional accessories: control strip with remote control switch and OIL ALARM plant.



43

Illustration in fig. 43:

1. Ignition key - 2. Voltage regulator - 3. Starter motor - 4. Battery - 5. Alternator - 6. Pressure switch - 7. Low battery charge indicator - 8. Low oil pressure indicator.



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CABLES: Colour x Section mm²

CABLE COLOURS: B= white
M= brown
N= black
R= red
V= green

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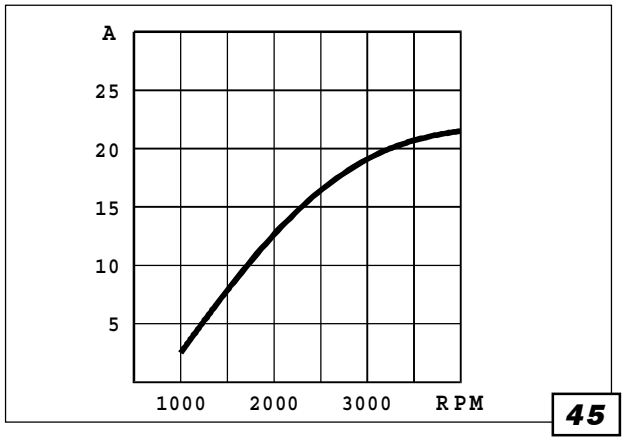
11.2 Checking the system

1) make sure that the connections between the regulator and alternator are correct and in good conditions
2) detach the wire from the remote control switch from the terminal and fit on a d.c. amperometer (Ⓐ ,fig. 44)
3) coconnect a d.c. voltmeter to the battery terminals (Ⓥ), fig. 44)
4) make a few no-load starts or introduce a **80–100W** lamp load at the battery lugs to keep the battery voltage below **13V**.
5) accelerate the engine to a **3000 rpm** rate. The current indicated on the amperometer must correspond to the values in fig. 45.
6) disconnect the load (if any) and keep the engine at the above mentioned rate for a few minutes. The battery voltage must progressively increase until reaching about **14.2 V**. Meanwhile, the charge voltage must drop to a minimum value of about **2A**, with a speed determined by the battery charge condition.
7) if charge current is missing or is less than the given values, check the alternator and replace the voltage regulator if necessary.

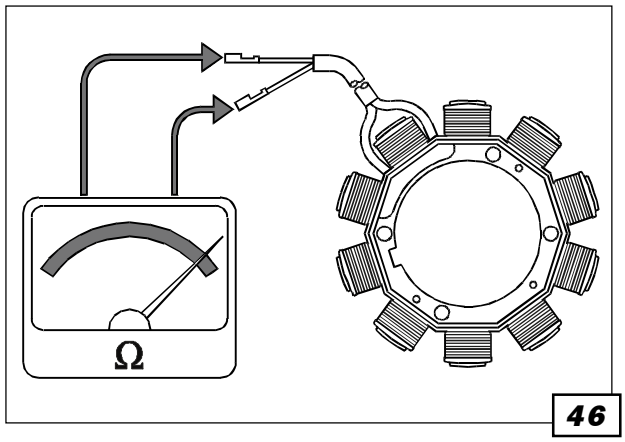


45

11.3 Checking the alternator

With the engine at a standstill, disconnect the alternator wires from the regulator and check:

1) using an ohmmeter, that the windings (fig. 46), null resistance) and the insulation between wires and ground (fig.47, infinite resistance) are unbroken. Replace the stator if interruptions are discovered;
2) with a voltmeter, the voltage between the two yellow wires (fig. 48). Accelerate the engine to **3000 rpm**. The voltage must be **33V**.
   If the values are more than 10V less than this, it means that the rotor is demagnetized and that the alternator must be replaced.



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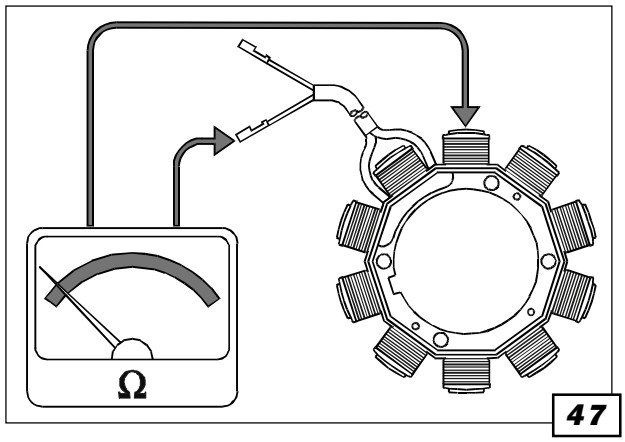


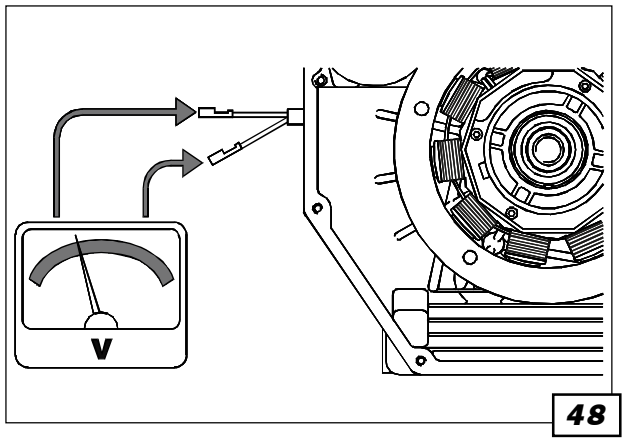
47

Warning:

1) the alternator does not deliver current when the yellow cables are isolated
2) the alternator burns out if the yellow wires are grounded
3) the regulator may be damaged if the ground connection or electrical connections are made in a slapdash way.
4) the alternator and regulator will immediately burn out if the battery connections are inverted.

11.4 Ring gear

Make sure that the teeth of the crown wheel are not worn or damaged. Heat the starting ring gear to a temperature of 200-250 °C before fitting it on to the flywheel .



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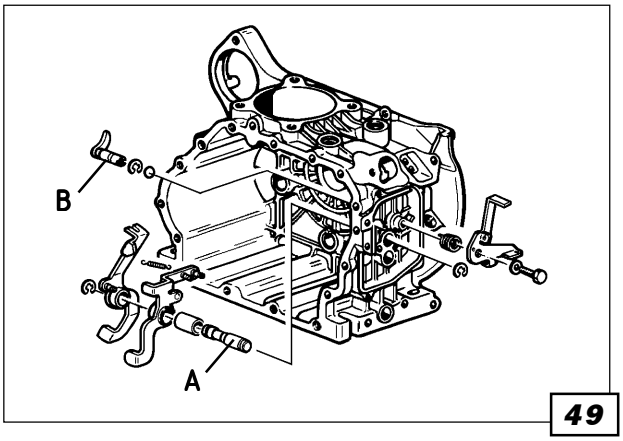
12. ENGINE ASSEMBLY

Important:

The instructions refer to engines updated at the time of publication. Check the technical circulars for any modifications.
Thoroughly clean the parts before remounting them.
Lubricate the moving parts to prevent seizures when the engine is first started.
Replace the seals whenever the parts are remounted.
Use torque wrenches to tighten to the correct values.

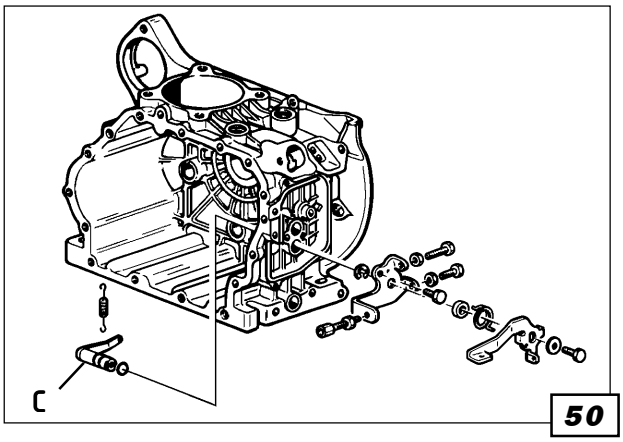


49

12.1 Preparing the engine block

remove all traces of sealant or impurities from the bearing surfaces with a copper plate or lapping stone, then proceed in the following way:

1) Fit on the oil drain plugs without tightening them too much (max. 2 Kgm) to prevent damage to the threads.
2) Mount the main bearing as indicated in section 8.6 on page 12.
3) Fit the benzing ring on to the pin of the regulator levers (fig. 49-A); apply Loctite 648 to the zone where the pin touches the engine casing.
   Insert the stop lever (fig. 49-B), the accelerator lever (fig. 50-C) and complete the assembly operations in compliance with the sequencies indicated in figures 49 and 50.
4) Comply with the sequence indicated in fig. 51 for the "motorstop" version.



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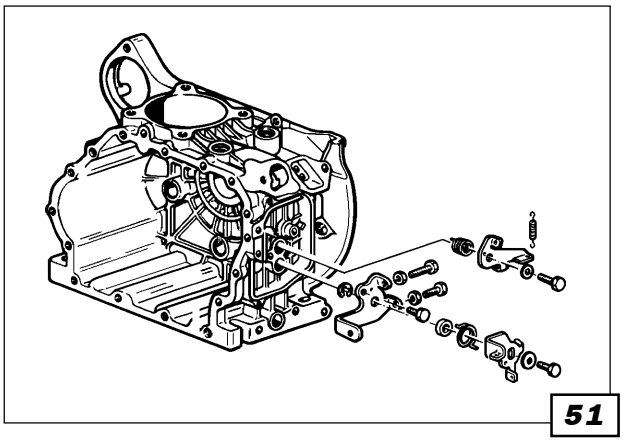
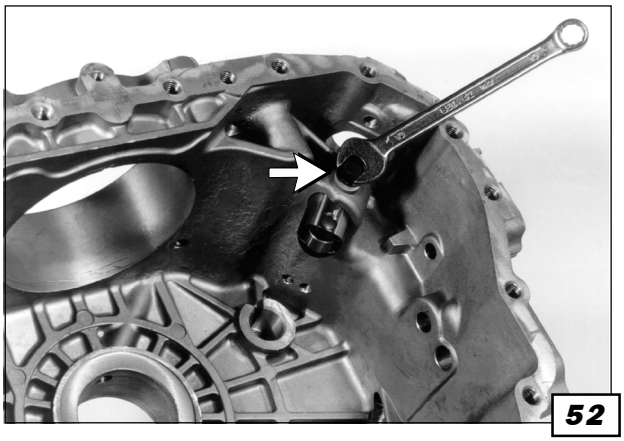

51

12.2 Injection pump tappets

Insert the tappet into the injection pump housing in the engine casing.
Fit the screw into the guide as shown in fig. 52


52

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12.3 Timing system cover pre-assembly

Prepare the cover of the timing system in the following way:

1) Mount the main bearing as indicated in section 8.6 on page 12.

2) Fit in the pin and drive shaft bearing ring (fig 53).

3) Mount the oil pump rotors as described in section 9.11 on page 17. Insert the plug and driving pin as shown in fig. 54-A. Fix the oil pump cover in place by tightening the screws to the following torque value:

0.8 to 1.0 Kgm
(7.8 to 9.8 Nm)

4) Insert the by-pass valve using tool code 366.21 (fig. 55); mount the by-pass check screw with Loctite 648; mount the by-pass valve inspection plug on the outside of the cover on the timing system side.

5) Fit the retainer cap on the oil intake duct at the base of the cover on the timing system side, using Loctite 648 (fig. 54-B).

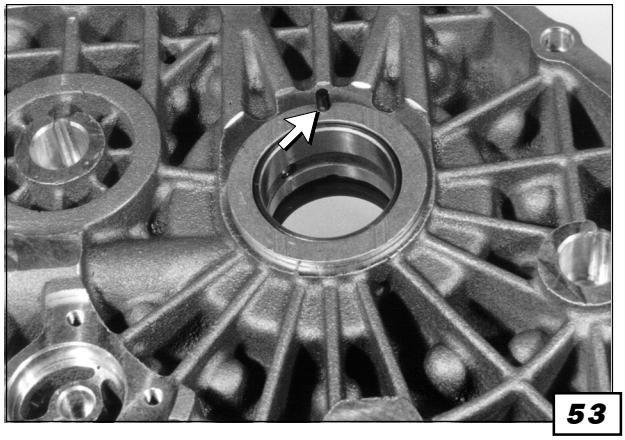
6) Tighten the internal oil filter (fig. 54-C).

7) Fit on the engine oil filter and relative plug including the O-Ring (fig 54-D).

8) Mount the rpm governor, in compliance with the alphabetical sequence given in fig. 56.

9) Fit in the fuel flow limiter

10) Mount the oil retention ring as indicated on page 27 fig.67.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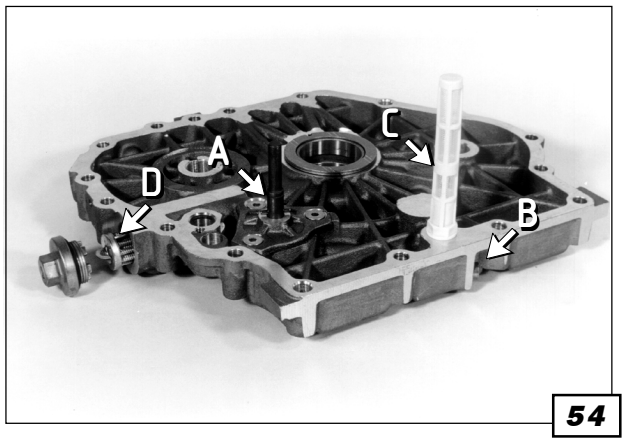

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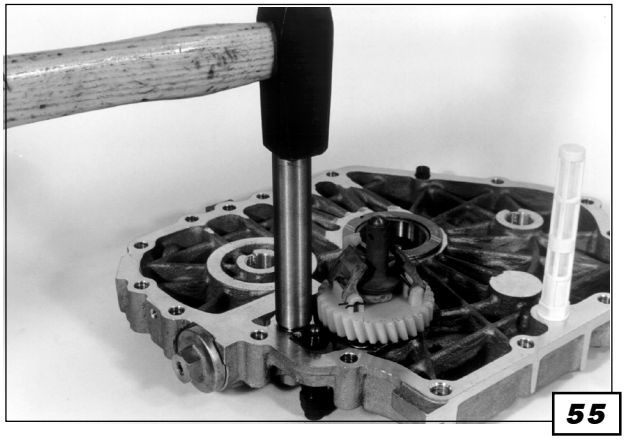
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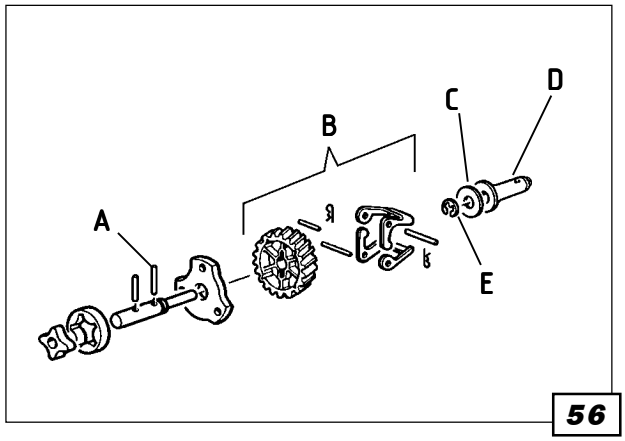


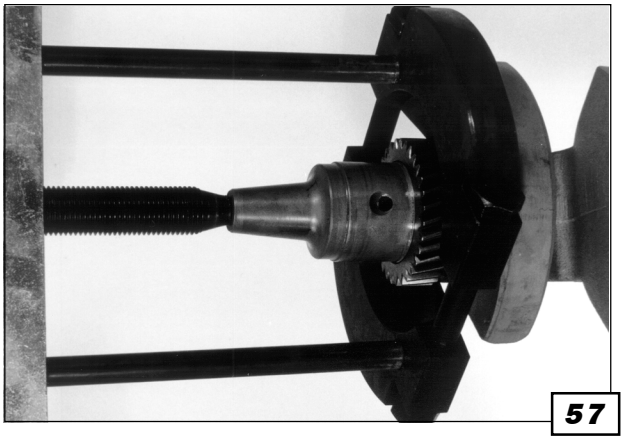
56

12.4 Removal and assembly of the drive shaft gear

The gear on the timing system side can only be replaced.

To demount it, use puller code 365.10 (fig. 57) or a puller available on the market.

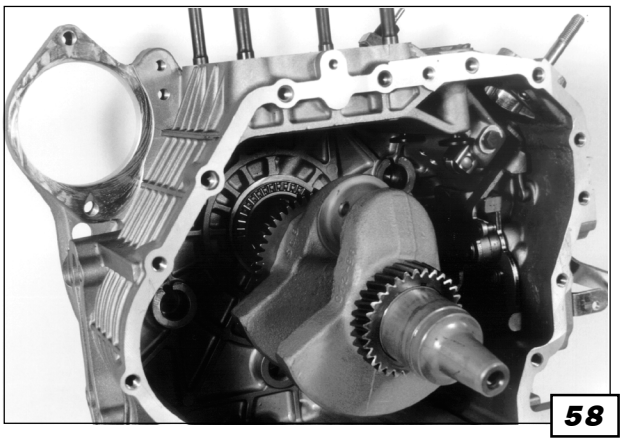
To assemble, preheat the gear to a temperature of about 180 to 200 °C, fit it on the shaft, taking care to ensure that the chamfer points towards the internal part, and use the tang as a reference.



57

12.5 Drive shaft assembly (fig. 58)

Mount the drive shaft after having fixed the first shimming washer to the casing with Loctite 648 and after having inserted the needle bearing and the second shimming washer.



58

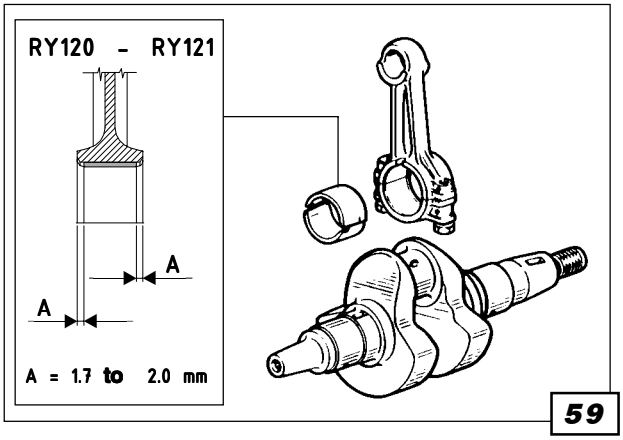
12.6 Connecting rod - drive shaft connection

After having fitted the bearings into the small end, connect the connecting rod to the crank pin as shown in fig. 59.
Mount the connecting rod cap with the reference numbers matching those on the rod.

WARNING: for series RY120 and RY121 engines, mount the connecting rod half bearing with the positioning mark on the cap and that without positioning mark in the center of the rod, in compliance with the dimensions indicated in fig. 59.

Evenly tighten the connecting rod bolts to the following value:

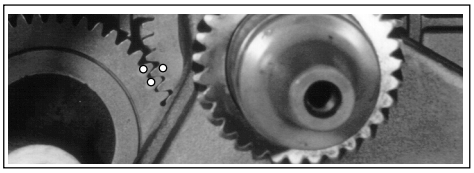
3.8 to 3.9 Kgm
(37.3 to 38.2 Nm)

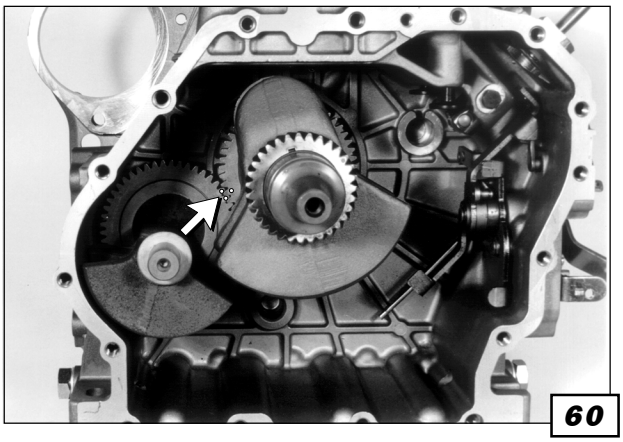


59

12.7 Counter-shaft

Insert the counter-shaft, matching the reference marks on the gears (fig. 60).

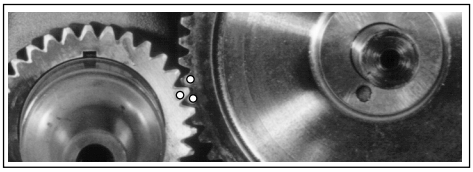


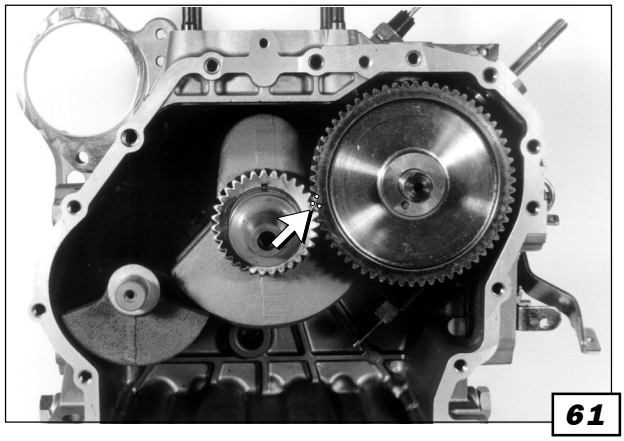


60

12.8 Camshaft

Insert the tappets into their housings on the casing. Mount the camshaft, matching the reference marks on the gears (fig.61).





61

12.9 Play adjustment

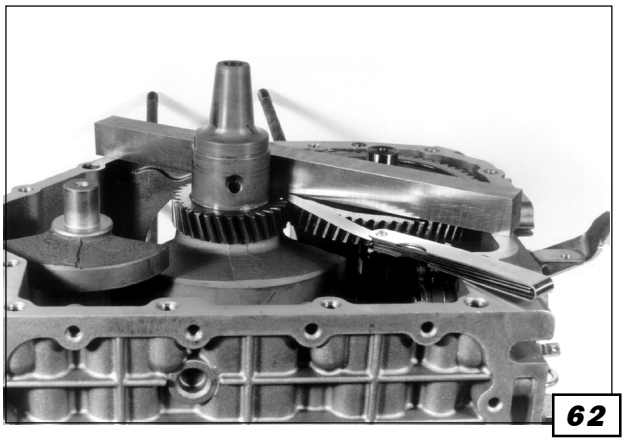
Crankshaft float:

Place a calibrated bar on the casing, on a level with the timing system cover retention surface and use a thickness gauge to check the distance between the gear and bar (fig. 62). Note down the value measured.

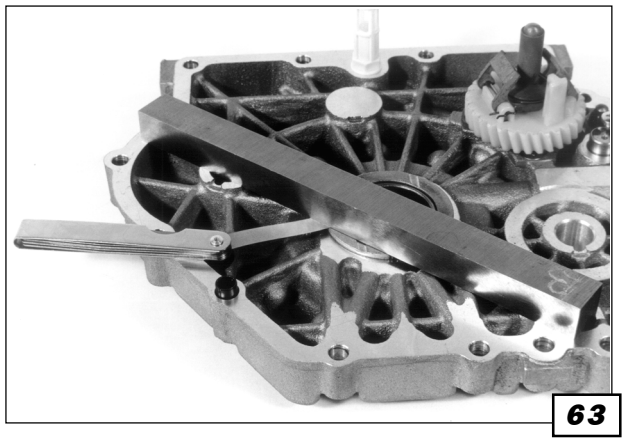
Place a calibrated bar on the cover of the timing system, on a level with the engine casing retention surface and use a thickness gauge to check the distance between the bearing ring and bar (fig. 63). Note down the value measured.

The sum of the two measured values must be within:

0.10 to 0.30 mm



62

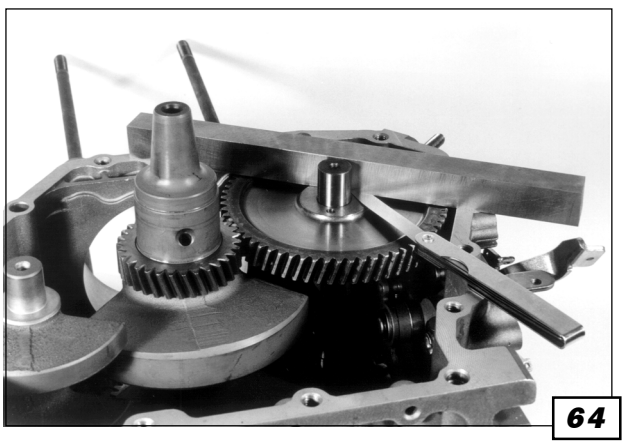


63

Camshaft float:

Place a calibrated bar on the casing, on a level with the timing system retention cover and use a thickness gauge to check the distance between the gear and bar (fig. 64). The value must be between:

0.10 to 0.25 mm



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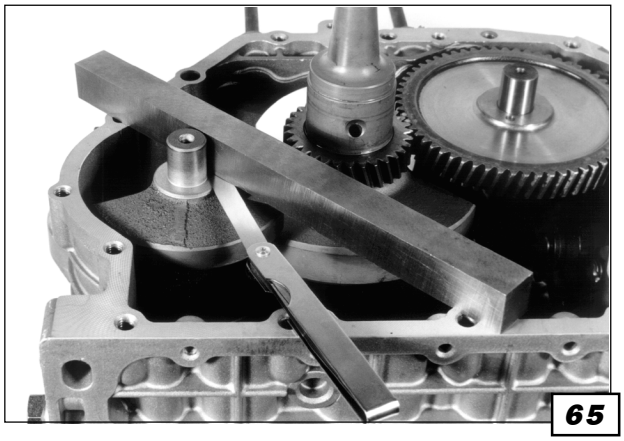
Counter-shaft float (optional):
Place a calibrated bar on a level with the timing system cover retention surface and use a thickness gauge to check the distance between the stop surface and bar (fig. 65). The measured value must be between:

0.10 to 0.25 mm


65

12.10 Cover on timing system side
Spread liquid seal of the AREXON D 0036 MOTORSIL type on the retention surface of the timing system cover (fig.66).
Place the cover on the casing.
Insert the cover fixing screws, making sure that the five shorter ones (40 mm) are mounted in the top part of the cover. Tighten to the following torque value:

2.7 to 2.8 Kgm (26.5 to 27.5 Nm)

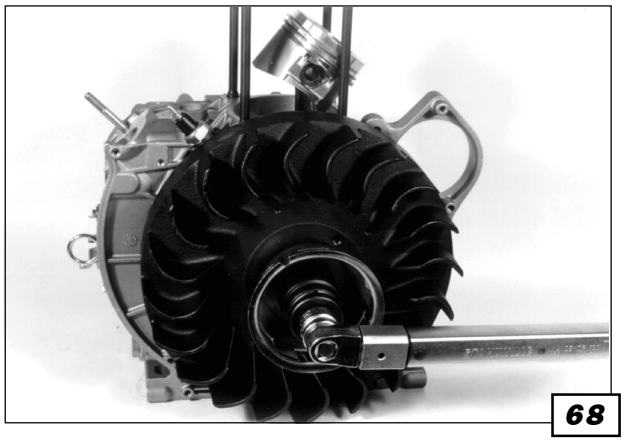
66

12.11 Oil retention rings
1) Immerse the retention ring in oil for about 10 minutes.
2) Clean the housing and insert the ring with a plug, exercising an even pressure all over the surface (fig.67).

67

12.12 Flywheel
Block the flywheel (fig. 68) and torque the nut to value:

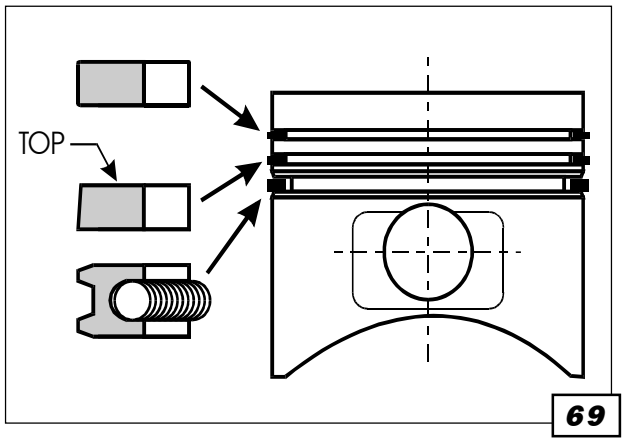
18 to 20 Kgm (176.5 to 1961 Nm)


68

12.13 Piston

Mount the rings on the piston (fig. 69) in the following order:
1) chromium plated compression retention ring (stamped trademark pointing upwards)
2) tapering retention ring (stamped word TOP pointing upwards)
3) oil scraper ring (stamped trademark pointing upwards)

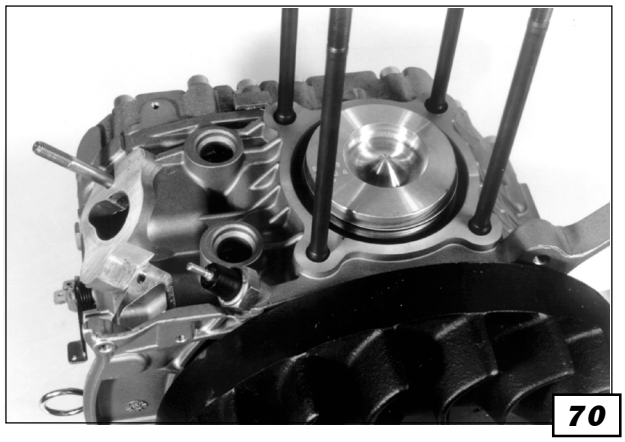
Position the piston so that the central axis of the combustion chamber is aligned with the injector (fig.70). Connect the piston to the connecting rod, slightly pressing with the hand on the pin.



69

12.14 Cylinder

Insert the cylinder into the engine casing after having inserted the 0.3 mm thick seal.
before mounting, turn the rings through 120°, one in relation to the other, with the first compression ring pointing with its ends on a level with the pin axis.
There is a chamfer to allow ring insertion on the lower side of the cylinder. The operation is simplified by using a normal ring mounting tool code **365.77** as indicated in fig. 71.


70

Move the piston to TDC (top dead center) and check that the mark stamped on the flywheel corresponds to the reference pointer of the tool code **366.24** (see section 12.17).
To obtain the correct clearance, use a head seal of adequate thickness:
1) check the piston projection as shown in fig. 72
2) Choose the seal as indicated in the following table

71

Piston projection (mm)	Seal thickness (mm)
0.00 to 0.10	0.8
0.10 to 0.20	0.9
0.20 to 0.30	1.0
0.30 to 0.40	1.1

NOTE: The distance between piston crown and the corresponding head surface must be:

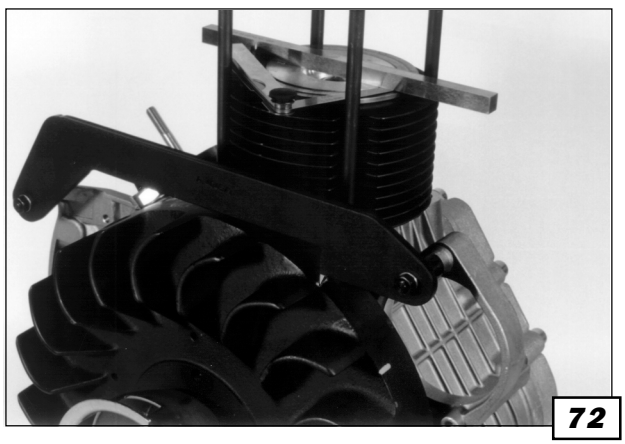
0.7 to 0.8 mm

12.15 Head

Before fixing the head to the cylinder, fit the injector into its housing and, after having temporarily fixed it, check that the distance the nozzle projects from the surface of the head by (fig. 73):

2.2 to 2.7 mm

regulate by placing copper washers between the injector and the bearing surface on the head.
Consult sections 9.1 and 9.2 for the relative inspections and overhauls.


72

Insert the rocker arm casings, the partition (A, fig. 75), the head seal and the head. Tighten the head fixing nuts evenly and alternately (fig. 74) to the following value:

4 Kgm (39.2 Nm)

NOTE: To prevent oil leaks, apread sealant (Motorsil) on the threads of the stud bolts and washer bearing surfaces in the rocker arm chamber before tightening the nuts.

12.16 Valve play

Adjust the play between valves and rocker arms in either a **hot or cold condition**, to the following values (fig. 75):

hot	0.15 mm (intake/exhaust)
cold	0.20 mm (intake/exhaust)

Since the automatic decompression device opens the exhaust valve near TDC, play must be adjusted during the expansion phase, a few degrees after TDC.

12.17 Injection lead

To ensure the injection lead is accurately adjusted, it is advisable to define the shims to insert under the pump by measuring the dimension between the pump bearing surface and the tappet. Proceed in the following way:

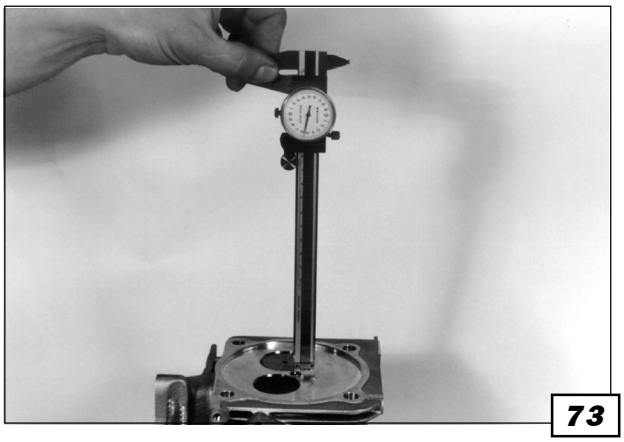
1) turn the flywheel to the compression phase
2) insert the tappet pad into the housing in the engine block, pointing the exhaust side towards the tappet roller (see fig. 30 page 18)
3) align the dynamic lead punch mark (**IP**) on the flywheel with the reference mark of the tool code **366.24** (fig. 76)
4) using a depth gauge (fig. 77), measure the dimension between the injection pump bearing surface and the tappet pad.
5) subtract **51.6 mm** from the dimension measured on the gauge; the result represents the theoretic thickness of the seals to insert under the injection pump.

NOTE: if the flywheel or a crank component is replaced, make sure that the punch mark on the flywheel (TDC, fig. 76) and the reference mark of the tool code **366.24**, match when the piston is at top dead center

Lead values in degrees and millimeters on the flywheel:

LEAD
IP
24°±1° (56.6 mm)

The punch marks on the flywheel indicate (fig. 76):
TDC = top dead center
IP = start of delivery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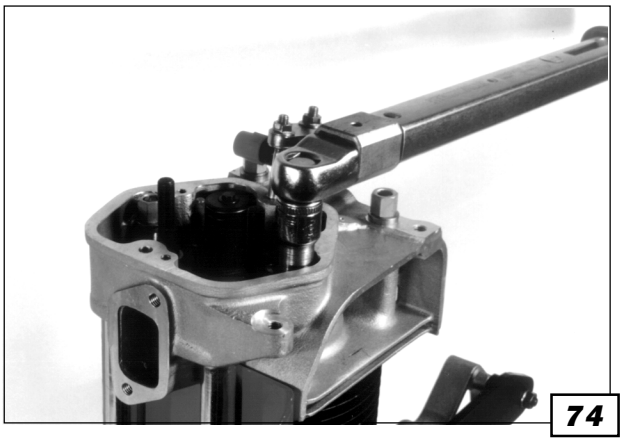
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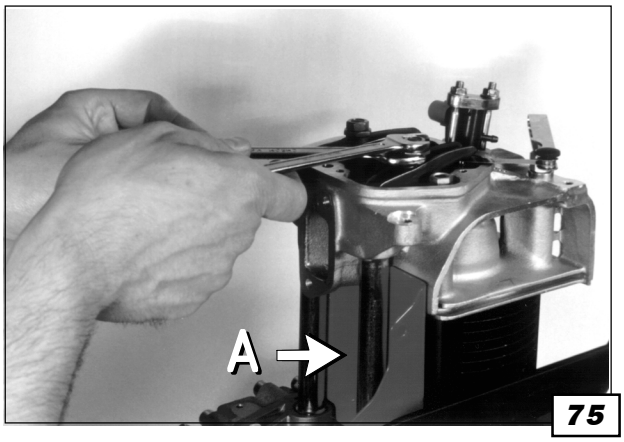

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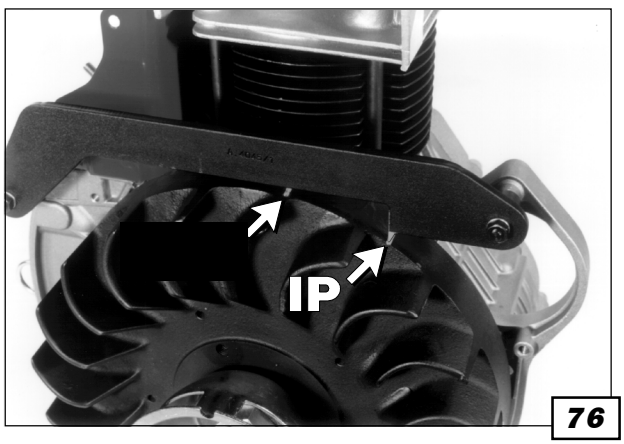

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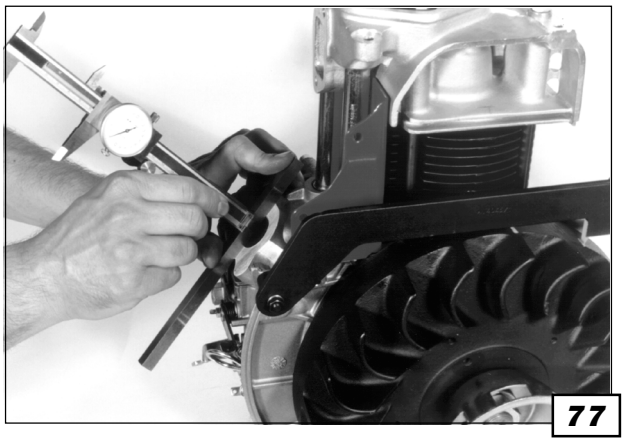
12.18 Mounting the injection pump on the engine

Lower the tappet in the innermost point of the engine by slightly turning the flywheel.
Insert a seal of adequate thickness (see section 12.17 point 6).
Turn the motor stop lever to the STOP position.
Set the adjuster sleeve of the injection pump about one millimeter from the stop position on the adjuster block (fig. 78).
Fit the injection pump into the engine block and, keeping it pressed down, fix it in place by tightening the nut that holds the relative bracket.
(Match the marks made during the demounting phase, see section 8.2)

Warning: consult chapter 13.2 if the position of the injection pump in relation to the casing was not marked during the demounting operations or if a new one must be installed.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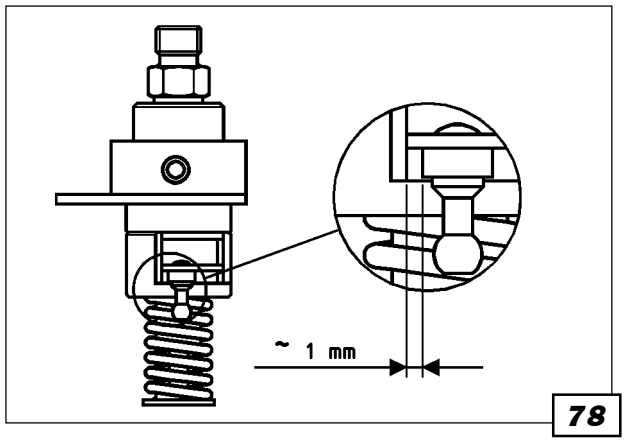
12.19 Injector and injector tube

Mount the injector on the head, inserting the copper retention seals (see section 12.15).
Connect the injector to the pump with the injection pipe.

Warning: always use two wrenches to slacken off or tighten injection pipes (fig. 79).



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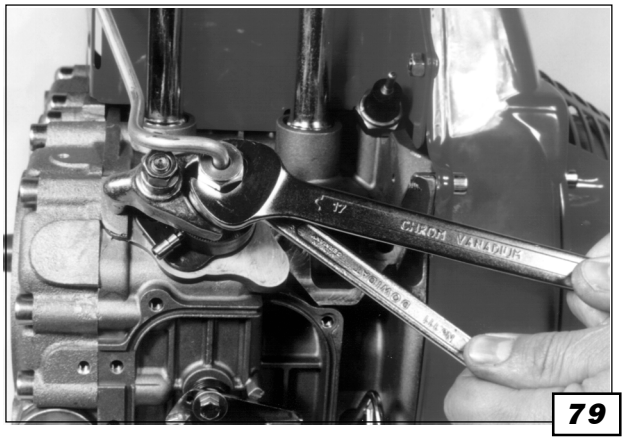
13. ENGINE TEST

13.1 Rpm regulation

Fill the engine with oil and diesel fuel and allow it to warm up for 10 minutes.
With the engine hot, adjust the idling rate (A, fig. 80) to **1,300 rpm** and the peak no-load rate (B, fig. 80) to:
- **3,150 rpm** for engines set at 3,000 rpm on load
- **3,750 rpm** for engines set at 3,600 rpm on load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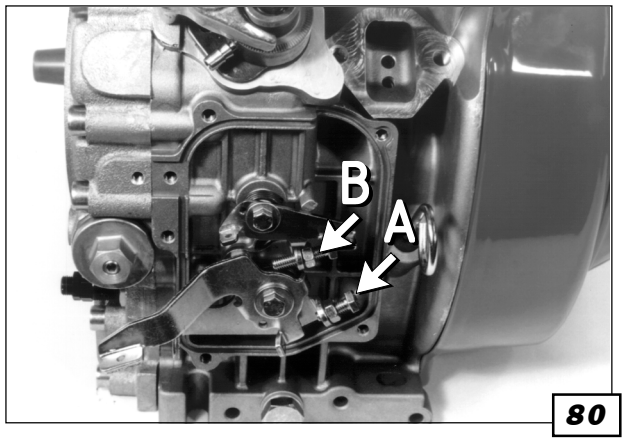
13.2 Braked engine test

Carry out the following operations after having positioned the engine on the brake:
1) Start the engine and allow it to idle
2) Allow the engine to run in before checking the maximum power

Running in table:

Time (min)	Rpm	Load
5	2000	0
15	3000/3600	0
30	3000/3600	30%
30	3000/3600	50%
30	3000/3600	70%
5	3000/3600	100%

Consult the power curves in chapter 2.



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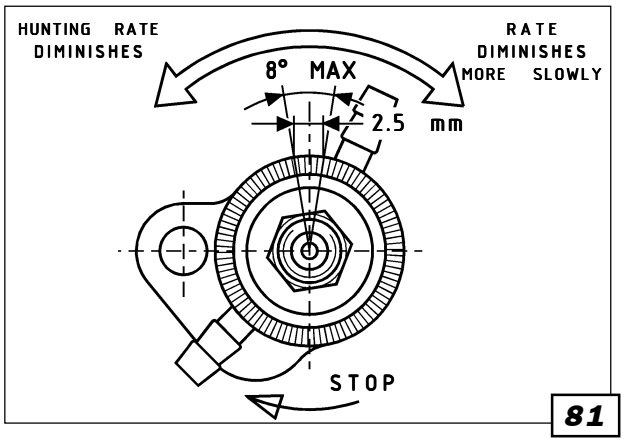
There may be hunting problems, slowness or misfiring if the injection pump is changed. Correct these faults by turning the pump casing a few degrees in relation to the engine casing, following the directions indicated in fig. 81.



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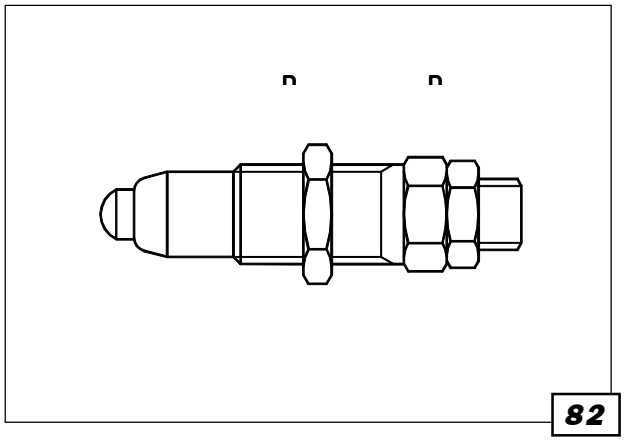
Fuel limiter.
The fuel limiter has a torque corrector device (fig. 82) that consists of the following parts:
A) Torque corrector cap
B) Maximum power flow rate adjuster
C) Spring load adjuster
D) Locking nuts

The adjustments can only be made to the exhaust brake. It is therefore inadvisable to tamper with the corrector adjuster (C fig. 82). The setting of adjuster B (fig. 82) can only be modified if work has been done on the injection pump or regulator, if the engine produces a lot of smoke or has insufficient power.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14. STORAGE

Engines that are to remain unused for a long period of time must be prepared in the following way:

14.1 Storage for up to 6 months

- allow the engine to idle at a low rate for about 15 min.
- change the fuel filter, pour a mixture of diesel fuel and 10% AGIP RUSTIA 81 protective oil into the tank
- turn the engine over for about 10 minutes at a speed of between 1/2 and 3/4 of its normal rate so that the pipes, injectors, pumps and filters and filled with the protective mixture
- spray AGIP RUSTIA C SAE 30 into the exhaust and intake ducts and turn the starter pulley by hand
- thoroughly clean the fins, the radiator and the external parts of the engine. protect the unpainted external surfaces with AGIP RUSTIA C SAE 30 oil
- seal the exhaust pipe and air filter with adhesive tape
- wrap the engine in a plastic sheet

14.2 Storage periods of more than 6 months

Besides the above operations, also:
- allow the engine to operate with AGIP RUSTIA C SAE 30 protective oil
- periodically inspect the engine and make sure that there are no traces of rust or corrosion

14.3 Setting at work

- remove the protective covers
- remove the external protective coating with solvent or degreaser
- check the injector settings, the valve play. Make sure that the heads and filters are well tightened
- proceed with the normal preliminary inspections prior to starting
- **if the engine has been filled with AGIP RUSTIA C SAE 30 protective oil, replace this after at least 100 hours service.**

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15. SUMMARIZING TABLES

15.1 Couplings	*Play (mm)*	*Limit (mm)*
Camshaft and plugs	0.032 - 0.061	0.1
Compression ring opening	0.30 - 0.50	0.8
Oil scraper ring opening	0.25 - 0.50	0.8
Connecting rod and piston pin	0.023 - 0.038	0.04
Injection pump tappets and housing	0.021 - 0.059	0.1
Tappets and housing	0.005 - 0.029	0.1
Pin and piston	0.003 - 0.013	0.04
Intake guide and valve	0.030 - 0.050	0.1

15.2 Adjustments	*MIN (mm)*	*MAX (mm)*
Camshaft float	0.1	0.25
Countershaft float	0.1	0.25
Crankshaft float	0.1	0.3
Connecting rod float	0.3	0.5
Connecting rod radial play	0.019	0.046
Regulator pin float	0.2	0.3
Valve play when hot [cold]	0.15 [0.20]	0.15 [0.20]
Valve recessing	0.8	1
Injector projection	2.2	2.7
Piston projection	0.1	0.4

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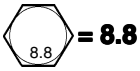
15.3 Driving torques	*Kgm*	*(Nm)*
Timing system cover	2.7 - 2.8	26.5 - 27.5
Injector ring nut	4.6 - 5.6	45 - 55
Injection tube unions	2 - 2.5	19.6 - 24.5
Injector bracket	0.8 - 0.9	7.8 - 8.8
Injection pump bracket	2	19.6
Head	4	39.2
Flywheel	18 - 20	176.5 - 196.1
Connecting rod	3.8 - 3.9	37.3 - 38.2

15.4 Standard driving torques

Diameter x pitch	**8.8** Steel with a high % of C		**R10** Steel alloys		**R12** Special alloys	
mm	**Kgm**	**(Nm)**	**Kgm**	**(Nm)**	**Kgm**	**(Nm)**
4 x 0.70	0.37	(3.6)	0.52	(5.1)	0.62	(6.1)
5 x 0.80	0.72	(7.1)	1.01	(9.9)	1.22	(12.0)
6 x 1.00	1.23	(12.1)	1.73	(17.0)	2.08	(20.4)
7 x 1.00	2.02	(19.8)	2.84	(27.8)	3.40	(33.3)
8 x 1.25	3.02	(29.6)	4.25	(41.7)	5.10	(50.0)
9 x 1.25	3.88	(38.0)	5.45	(53.4)	6.55	(64.2)
10 x 1.50	5.36	(52.6)	7.54	(73.9)	9.05	(88.7)
13 x 1.75	9.09	(89.1)	12.80	(125.5)	15.30	(150.0)
14 x 2.00	13.80	(135.3)	19.40	(190.2)	23.30	(228.5)
16 x 2.00	21.00	(205.9)	29.50	(289.3)	35.40	(347.1)
18 x 2.50	26.30	(257.9)	37.00	(362.8)	44.40	(435.4)
20 x 2.50	36.60	(358.9)	51.50	(505.0)	61.80	(606.0)
22 x 2.50	44.40	(435.4)	62.40	(611.9)	74.90	(734.5)
24 x 3.00	56.90	(558.0)	80.00	(784.5)	96.00	(941.4)



= 8.8

= R10 = 10.9

= R12 = 12.9

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Descrizioni e illustrazioni non impegnative.

SUGGESTIONS ON HOW TO TIME THE INJECTION PUMP WHEN THE LEAD PUNCH MARKS ON THE FLYWHEEL ARE DIFFICULT TO REACH.
(Consult chapter 12.17 on page 29 for a description of the conventional adjustment)

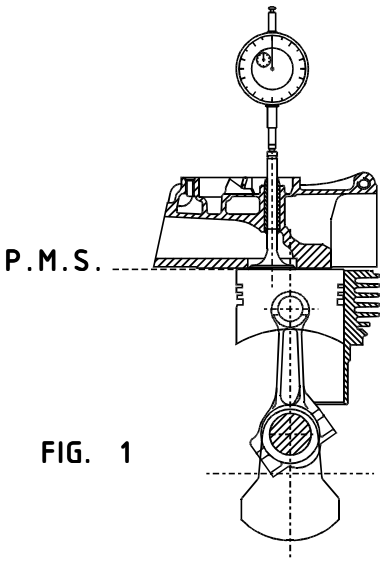

FIG. 1

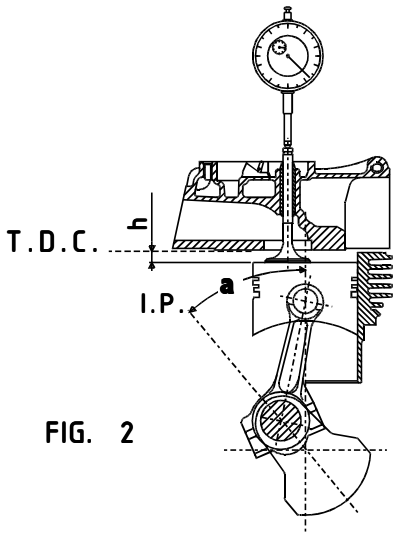

FIG. 2

T.D.C. = top dead center

h = extent of piston lowering in relation to T.D.C.

a = angle corresponding to piston lowering in relation to T.D.C.

I.P. = start of delivery

Proceed in the following way:

1) Remove the cover from the rocker arms.
2) Demount the recoil and turn the drive shaft to the valve regulation position.
   (This operation is carried out by means of the fylwheel nut, using a N° 32 socket wrench).
3) Demount the intake or exhaust rocker arm, the valve spring and caps.
4) Rest the valve top on the crown of the T.D.C. balanced piston (fig.1).
   WARNING: The valve slips from its guide if the piston is lowered by turning the drive shaft more than 1/4 of a pipe wrench turn.
5) Position a comparator mounted on a magnetic pedestal or dummy injector and reset it on the valve stem (fig.1).
6) Slowly turn the drive shaft in an anti-clockwise direction and check the comparator to make sure that the piston drops about 5 mm in relation to T.D.C. (dimension "h" - fig. 2).
7) Slowly turn the drive shaft in a clockwise direction and check the comparator to make sure that the piston rises by the values indicated in the following table, in relation to T.D.C. (dimension "h" - fig. 2):

LEAD	
h	**a**
4.12 mm	24°

8) Remove the injection tube and mount the capillary tube **code 365.94** on the injection pump delivery fitting (fig. 3).
9) Turn the accelerator lever to the MAX position and the stop lever to about half travel.
10) Turn the drive shaft anti-clockwise by no more than 1/4 of the pipe wrench turn.
11) Pressurize the circuit by turning the drive shaft several times in an alternate clockwise/anti-clockwise way until fuel splashes out of the calibrated hole of the capillary tube.
12) Turn the drive shaft and check the comparator to make sure that the piston drops about 10 mm in relation to T.D.C. (dimension (quota "h" - fig. 2).
13) Shake the capillary tube until an air bubble forms inside it (fig. 3).
14) Turn the drive shaft in a clockwise direction very slowly and check the position of the air bubble in the capillary tube. A small movement of this bubble will indicate the exact lead position. This value must correspond to the one previously read on the comparator (see point 7). If this is not the case, add or remove seals to or from the injection pump according to the corrections indicated in the following table:

Comparative lead adjustment table

	h	**a**	**Seal thickness for lead correction**
Value off tolerance	3.50	22°	- 0.2 mm
Value in MIN. tolerance	3.80	23°	- 0.1 mm
STD. LEAD	**4.12**	**24°**	**0**
Value in MAX. tolerance	4.50	25°	+ 0.1 mm
Value off tolerance	4.85	26°	+ 0.2 mm

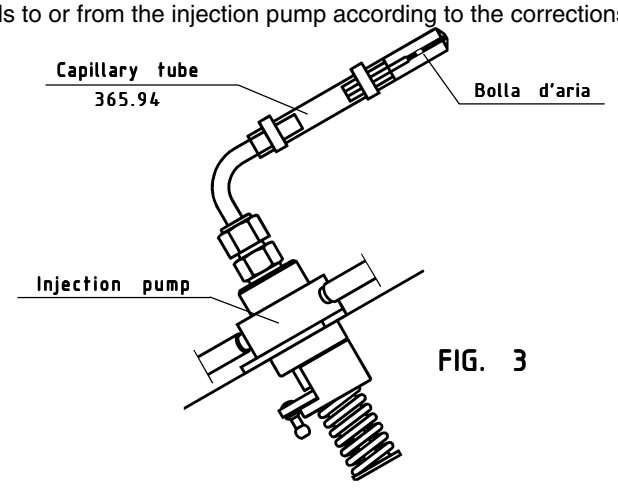

FIG. 3

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